化 學

梁傑(梁家榮)老師提供

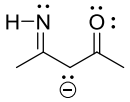
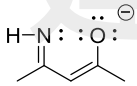
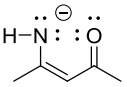
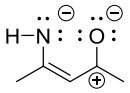
Choose one best answer for the following questions

【單選題】每題 1 分，共計 30 分，答錯 1 題倒扣 0.25 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。
1~15 題為物理，16~30 題為化學。

(C) 16. Using the rules of significant figures, calculate the following: $0.102 \times 0.0821 \times 273/1.01$
(A) 2.2635 (B) 2.264 (C) 2.26 (D) 2.3 (E) 2.66351

(A) 17. Which of the following best describes an orbital?
(A) Space where electrons are likely to be found in an atom.
(B) Space which may contain electrons, protons, and/or neutrons.
(C) The space in an atom where an electron is most unlikely to be found.
(D) Small, walled spheres that contain electrons.
(E) A single space within an atom that contains all electrons of that atom.

(C) 18. Which of the following is the correct electron configuration for OF^-?
(A) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}{}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}{}^2\,\pi_{2p}{}^2$
(B) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}{}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}{}^2\pi_{2p}{}^4\pi^*_{2p}{}^2$
(C) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}{}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}{}^2\pi_{2p}{}^4\,\pi^*_{2p}{}^4$
(D) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}{}^2\,\sigma^*_{2s}{}^2\,\pi_{2p}{}^1$
(E) None of the above.

(B) 19. Which of the following resonance structures is the most stable?
(A) 
(B) 
(C) 
(D) 
(E) All of them are the same.

(E) 20. Which of the following does **NOT** contain at least one pi bond?
(A) H_2CO (B) CO_2 (C) C_2H_2
(D) NO (E) All of the above (A-D) contain at least one pi bond.

(B) 21. Order the intermolecular forces (dipole-dipole, London dispersion, ionic, and hydrogen-bonding) from weakest to strongest.
(A) dipole-dipole, London dispersion, ionic, and hydrogen-bonding
(B) London dispersion, dipole-dipole, hydrogen-bonding, and ionic
(C) hydrogen-bonding, dipole-dipole, London dispersion, and ionic
(D) dipole-dipole, ionic, London dispersion, and hydrogen-bonding
(E) London dispersion, ionic, dipole-dipole, and hydrogen-bonding

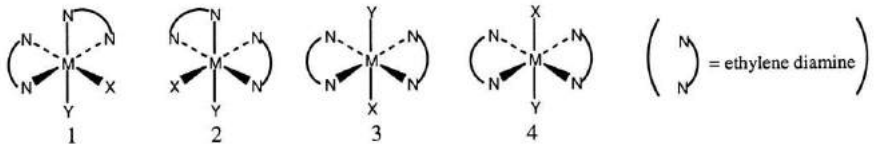
(D) 22. Which separation technique is based on differences in the affinity of the substances to be separated?
(A) filtration (B) distillation (C) solvent extraction
(D) paper chromatography (E) None of the above.

(A) 23. Which of the following gives correct rank of the ionization energies for Cs, Na, O, F, and S?
(A) Cs < Na < S < O < F (B) Cs < S < Na < O < F (C) F < O < Na <S < Cs
(D) F < O < S < Na < Cs (E) Na < S < Cs < F < O

(E) 24. Naturally occurring copper exists in two isotopic forms: ^{63}Cu and ^{65}Cu. The atomic mass of copper is 63.55 amu. What is the approximate natural abundance of ^{63}Cu?
(A) 63% (B) 90% (C) 80% (D) 85% (E) 72%

(C) 25. The correct mathematical expression for finding the molar solubility(s) of $Al(OH)_3$ is _____.
(A) $9\,s^2 = K_{sp}$ (B) $3\,s^3 = K_{sp}$ (C) $27\,s^4 = K_{sp}$ (D) $s^4 = K_{sp}$ (E) $9\,s^3 = K_{sp}$

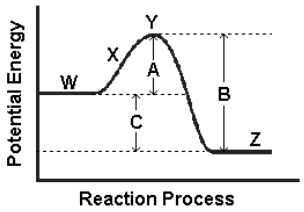
(B) 26. Consider the following octahedral complex structures, each involving ethylene diamine and two different, unidentate ligands X and Y. Which, if any, of the following pairs are optical isomers?



(A) 1 and 4 (B) 1 and 2 (C) 3 and 4
(D) 1 and 3 (E) None of the above.

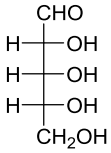
(B) 27. For which of the following processes would $\Delta S°$ be expected to be most positive?
(A) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(g)$
(B) $2NH_4NO_3(s) \rightarrow 2N_2(g) + O_2(g) + 4H_2O(g)$
(C) $H_2O(l) \rightarrow H_2O(s)$
(D) $N_2O_4(g) \rightarrow 2NO_2(g)$
(E) $O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$

(D) 28. Why is this reaction considered to be exothermic?



(A) Because energy difference A and energy difference C are about equal.
(B) Because energy difference B is greater than energy difference C plus energy difference A.
(C) Because energy difference A is greater than energy difference C.
(D) Because energy difference B is greater than energy difference A.
(E) Because energy difference B is greater than energy difference C.

(C) 29. The structure of pentose is shown on the down figure. How many carbon atoms with chirality are there in this molecule?



(A) 1 (B) 2 (C) 3 (D) 4 (E) 5

(C) 30. Which one is Bragg equation?
(A) $F = ma$ (B) $H\phi = E\phi$ (C) $n\lambda = 2d\sin\theta$ (D) $\Delta x \cdot \Delta p = h$ (E) $E = mc^2$

【單選題】每題 2 分，共計 120 分，答錯 1 題倒扣 0.5 分，倒扣至本大題零分為止，未作答，不給分亦不扣分。
31~60 題為物理，61~90 題為化學。

(B) 61. Regarding the reactions of organic compounds, which of the following statements is **NOT** true?
(A) The reaction of benzene and chloromethane can produce toluene.
(B) Methanol is prepared in industry by the hydrogenation of carbon dioxide.
(C) The commercial production of ethanol is carried out by the reaction of water with ethylene.
(D) Aldehyde can be produced commercially by the oxidation of *primary* alcohol.
(E) Ketone can be produced commercially by the oxidation of *secondary* alcohol.

(A) 62. Consider the following data concerning the equation:

$$H_2O_2 + 3I^- + 2H^+ \rightarrow I_3^- + 2H_2O$$

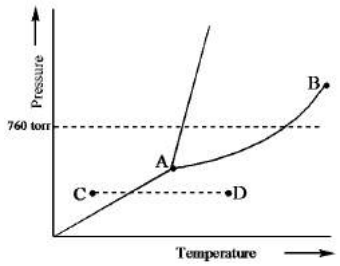
	$[H_2O_2]$	$[I^-]$	$[H^+]$	rate
I	0.100 *M*	5.00×10^{-4} *M*	1.00×10^{-2} *M*	0.137 *M*/sec
II.	0.100 *M*	1.00×10^{-3} *M*	1.00×10^{-2} *M*	0.268 *M*/sec
III.	0.200 *M*	1.00×10^{-3} *M*	1.00×10^{-2} *M*	0.542 *M*/sec
IV.	0.400 *M*	1.00×10^{-3} *M*	2.00×10^{-2} *M*	2.084 *M*/sec

(A) Rate = $k[H_2O_2][I^-][H^+]$ (B) Rate = $k[H_2O_2]^2[I^-]^2[H^+]^2$ (C) Rate = $k[I^-][H^+]$
(D) Rate = $k[H_2O_2][H^+]$ (E) Rate = $k[H_2O_2][I^-]$

(D) 63. Which of the following statements are true? A catalyst can act in chemical reaction to:
I. Lower the activation energy.
II. Change the equilibrium concentration of the products.
III. Decrease ΔE for the reaction.
IV. Change the order of the reaction.
V. Provide a new path for the reaction.
(A) I, II, and III (B) II and III (C) II and V (D) I and V (E) III and IV

(C) 64. Which of the following statements is true about the following electrochemical cell?
$Ca \mid Ca^{2+}(aq) \parallel K^{+}(aq) \mid K$
$Ca^{2+}(aq) + 2e^{-} \rightarrow Ca(s)$; $\varepsilon^{\circ} = -2.87$ V
$K^{+}(aq) + e^{-} \rightarrow K(s)$; $\varepsilon^{\circ} = -2.93$ V
(A) The cell reaction is spontaneous with a standard cell potential of 0.06 V.
(B) The cell reaction is nonspontaneous with a standard cell potential of −5.80 V.
(C) The cell reaction is nonspontaneous with a standard cell potential of −0.06 V.
(D) The cell reaction is spontaneous with a standard cell potential of 5.80 V.
(E) The cell is at equilibrium.

(D) 65. Examine the phase diagram for the substance Bogusium (Bo) and select the correct statement.



(A) Bo changes from a liquid to a gas as one follows the line from C to D.
(B) The triple point for Bo is at a higher temperature than the melting point for Bo.
(C) Bo changes from a solid to a liquid as one follows the line from C to D.
(D) Point B represents the critical temperature and pressure for Bo.
(E) Bo(*s*) has a lower density than Bo(*l*).

(A) 66. A 0.20 *M* solution of $MgSO_4$ has an observed osmotic pressure of 6.0 atm at 25°C. Determine the observed van't Hoff factor for this experiment.
(A) 1.23 (B) 2.00 (C) 1.66 (D) 1.80 (E) 1.45

(A) 67. Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula?
(A) $C_3H_5O_2$ (B) C_2HO_3 (C) $C_2H_5O_4$ (D) C_3HO_3 (E) $C_3H_3O_4$

(C) 68. On a new temperature scale (°L), water boils at 155.00°L and freezes at –10.00°L. Calculate the normal human body temperature using this temperature scale. On the Celsius scale, normal human body temperature is 37.0°C, and water boils at 100.0°C and freezes at 0.0°C.
(A) 57.30°L (B) 47.35°L (C) 51.05°L (D) 61.05°L (E) 41.05°L

(B) 69. When the following equation $C_2H_5OH + O_2 \rightleftharpoons CO_2 + H_2O$ is balanced, what are the coefficients?
(A) 2, 3, 1, 4 (B) 1, 3, 2, 3 (C) 1, 1, 1, 1 (D) 1, 2, 3, 4 (E) 1, 2, 2, 2

(C) 70. To form a buffer solution with pH = 9.0, how many moles of NH_4Cl should be added to 3.0 L of 0.20 *M* $NH_3(aq)$ at 25°C? (K_b of ammonia = 1.8×10^{-5}; assuming the volume of solution does not change after adding NH_4Cl)
(A) 0.36 (B) 0.72 (C) 1.08 (D) 3.6 (E) None of the above.

(D) 71. Which statement about hydrogen bonding is true?
(A) Hydrogen bonding is the intermolecular attractive forces between two hydrogen atoms in solution.
(B) The hydrogen bonding capabilities of water molecules cause $CH_3CH_2CH_2CH_3$ to be more soluble in water than CH_3OH.
(C) Hydrogen bonding of solvent molecules with a solute will not affect the solubility of the solute.
(D) Hydrogen bonding interactions between molecules are weaker than the covalent bonds within the molecule.
(E) Hydrogen bonding arises from the dipole moment created by the equal sharing of electrons within certain covalent bonds within a molecule.

(C) 72. How many effective atoms are there in a body-centered cubic unit cell?
(A) 1/2 (B) 1 (C) 2 (D) 3/2 (E) 3

(C) 73. Which of the following has a zero dipole moment?
(A) NH_3 (B) HCN (C) PCl_5 (D) SO_2 (E) H_2O

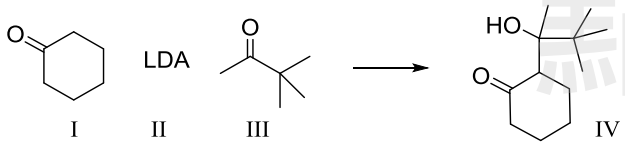
(B) 74. An electron is promoted from the π to the π* molecular orbital in an O_2 molecule following the absorption of a photon. Compared to the bond length in the non-excited molecule, the O_2 bond length will _____.
(A) be shorter (B) be longer (C) not be affected (D) be same (E) None of the above.

(A) 75. Determine the percent dissociation of a 0.18 *M* solution of hypochlorous acid, HClO. The K_a for the acid is 3.5×10^{-8}.
(A) 4.4×10^{-2} % (B) 3.5×10^{-6} % (C) 6.3×10^{-9} % (D) 4.4×10^{-4} % (E) 7.9×10^{-3} %

(E) 76. The solubility of $CaSO_4$ in pure water at 0 °C is 1.14 gram per liter. The value of the solubility product is _____.
(A) 7.01×10^{-5} (B) 8.37×10^{-3} (C) 7.01×10^{-2} (D) 8.37×10^{-5} (E) None of the above.

(C) 77. It is desired to determine the concentration of arsenic in a lake sediment sample by means of neutron activation analysis. The nuclide $^{75}_{33}As$ captures a neutron to form $^{76}_{33}As$, which in turn undergoes β decay. The daughter nuclide produces the characteristic γ rays used for the analysis. What is the daughter nuclide?
(A) $^{76}_{34}Se$ (B) $^{76}_{32}Ge$ (C) $^{74}_{31}Ga$ (D) $^{75}_{34}Se$ (E) $^{74}_{34}Se$

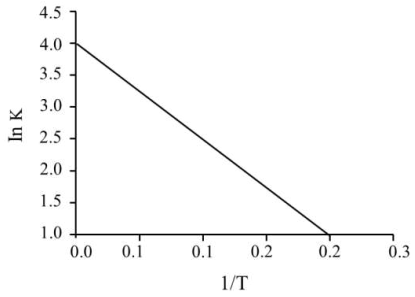
(B) 78. As shown below, compound IV can be prepared from reagents I, II, and III. Which of the following reaction conditions is the most suitable for the preparation of IV?



I II III IV

(A) I is slowly added to II, and III is then added to the above mixture.
(B) I is slowly added to II, and the resultant mixture is slowly added to III.
(C) II is slowly added to I, and III is then added to the above mixture.
(D) II is slowly added to I, and the resultant mixture is slowly added to III.
(E) I is slowly added to III, and II is then added to the above mixture.

(C) 79. The equilibrium constant of a certain reaction was measured at various temperatures to give the plot shown below. What is ΔS^o(J/mol·K) for the reaction? (R = 8.314 J/mol·K)



(A) 0.20 (B) 3.0 (C) −50 (D) -8.3×10^3 (E) 33

(E) 80. For the reaction $N_2(g) + 2H_2(g) \rightarrow N_2H_4(l)$, if the percent yield for this reaction is 41.0%, what is the actual mass of hydrazine (N_2H_4) produced when 30.57 g of nitrogen reacts with 4.45 g of hydrogen?
(A) 24.00 g (B) 28.60 g (C) 15.00 g (D) 12.00 g (E) 14.60 g

(C) 81. A sample of helium gas has been contaminated with argon gas. At 1 atm and 25°C, the density of the mixture is 0.200 g/L. What is the volume percent helium in the sample?
(A) 90.0% (B) 97.5% (C) 80.3% (D) 2.5% (E) 99%

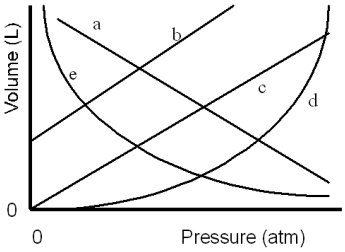
(B) 82. Which of the following is **NOT** a state function?
(A) entropy (B) enthalpy (C) internal energy (D) heat (E) temperature

(D) 83. A metal ion in a high–spin octahedral complex has four more unpaired electrons than the same ion does in a low–spin octahedral complex. The metal ion could be:
(A) V^{2+} (B) Cu^{2+} (C) Mn^{2+} (D) Cr^{3+} (E) Co^{2+}

(A) 84. Which of the following coordination compounds will form a precipitate when treated with an aqueous solution of $AgNO_3$?
(A) $[Cr(NH_3)_3Br_3]$ (B) $[Mo(Cl)_2(NH_3)_4](NO_3)$ (C) $Na_3[WCl_6]$
(D) $[Pt(NO^{linear})_2(OAc)_2](Br)_2$ (E) None of the above.

(C) 85. Which of the following species is diamagnetic?
(A) CN (B) B_2 (C) O_2
(D) All of the above. (E) None of the above.

(C) 86. Which of the lines in the figure below is the best representation of the relationship between the volume of a gas and its pressure, other factors remaining constant?

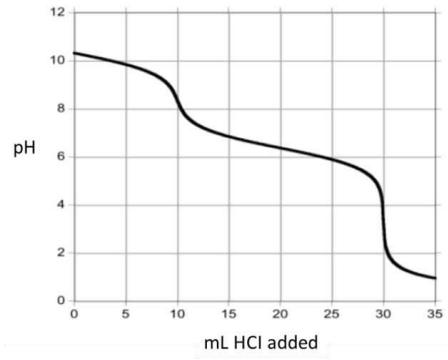


(A) a (B) b (C) c (D) d (E) e

(C) 87. Sulfur tetrafluoride adopts a see-saw geometry with two axial F atoms with a F–S–F angle of about 180º and two equatorial F atoms at about 90º from the axial fluorines. Which statement most accurately describes the axial and equatorial S–F bonds?
(A) The axial S–F bonds are longer because the two fluorine atoms must share bonding to the same orbital on sulfur.
(B) The axial S–F bonds are longer because they experience greater repulsion from the other fluorine atoms in the molecule.
(C) The equatorial S–F bonds are longer because the equatorial F–S–F bond angle is the smallest in the molecule.
(D) The equatorial S–F bonds are longer because they experience greater repulsion from the lone pair on sulfur.
(E) The equatorial S–F bonds are longer because they experience greater repulsion from two axial fluorine atoms.

(B) 88. According to the Haber-Bosch process, which statement is true?
(A) The reaction to produce NH_3 from H_2 and N_2 is reversible.
(B) According to the Le Châtelier's principle, the overall reaction is favorable to produce products in the state of high pressure.
(C) Increasing the reaction temperature can accelerate the reaction to equilibrium.
(D) Using Fe as a catalyst can accelerate the reaction to equilibrium, but cannot change the equilibrium between the reagents and products.
(E) All statement are true.

(B) 89. A sample of a washing powder that contains a mixture of Na_2CO_3 and $NaHCO_3$ is titrated with aqueous HCl and the following result is obtained:



What is the mole ratio of CO_3^{2-} to HCO^{3-} in the washing powder?
(A) 2 mole CO_3^{2-} : 1 mole HCO^{3-} (B) 1 mole CO_3^{2-} : 1 mole HCO^{3-} (C) 1 mole CO_3^{2-} : 2 mole HCO^{3-}
(D) 1 mole CO_3^{2-} : 3 mole HCO^{3-} (E) 3 mole CO_3^{2-} : 1 mole HCO^{3-}

(D) 90. A student gave a molecule the following name:
2-methyl-4-*t*-butylpentane
However, the teacher pointed out that, although the molecule could be correctly drawn from this name, the name violates the IUPAC rules. What is the correct (IUPAC) name of the molecule?
(A) 2-*t*-butyl-4-methylpentane (B) 2,4,5,5-tetramethylhexane
(C) 1-*sec*-butyl-1,2,2-trimethylpentane (D) 2-*t*-butyl-4-*iso*-propylbutane
(E) None of the above.

高雄醫學大學

第 61 題綜合了相當多有機的概念(雖然上課都有提到，但是大部分只準備普通化學的學生可能忽略)
第 78 題屬於有機化學課程才會講述的進階概念(普化課不會教)
第 87 題屬於較細節的觀念上課沒有特別提到(line 首頁提供同學下載的題目中其實有相關概念)
其餘題目都屬於相當基本的普化考題(看到有 21 題以紅字表示的完全命中就知道了)，有認真唸書的同學應該可以拿到高分。

第 16 題	第 17 題	第 18 題	第 19 題	第 20 題
有效數字運算	軌域的意義	雙原子分子的 MO	共振貢獻度	π 鍵數量的計算
普化總複習(1)	普化正課講義	普化總複習(2)	普化總複習(3)	普化總複習(2)
Page A-2	Page 5-58	Page D-50	Page 30	Page D-50
NTU99B(2)	完全命中	GOV106(28)	UST104A1&A5(2)	GOV104(36)
幾乎相同		幾乎相同	幾乎相同	幾乎相同

第 21 題	第 22 題	第 23 題	第 24 題	第 25 題
粒子間作用力大小	層析法原理	游離能大小比較	同位素含量計算	Ksp 與 S 之關係
普化總複習(1)	普化正課講義	考古題	普化總複習(3)	普化正課講義
Page B-17	Page 1-15	私醫 101(23)	Page 4	Page 12-92
NTU97B(20)	觀念相同	幾乎相同	NTU104C(6)	完全命中
完全命中			完全命中	

第 26 題	第 27 題	第 28 題	第 29 題	第 30 題
同位素含量計算	ΔS^0大小判斷	反應熱	掌性中心數量	Bragg 公式
普化總複習(1)	普化總複習(1)	考古題	考古題	普化正課講義
Page A-53	Page B-33	中國 107(15)	高醫 107(18)	Page 8-47
UST99A5(7)	UST97A5(12)	幾乎相同	幾乎相同	完全命中
完全命中	幾乎相同			

第 61 題	第 62 題	第 63 題	第 64 題	第 65 題
有機化學	初速率法求級數	催化劑的影響	cell diagram 與	相圖判讀
普化正課講義	普化總複習(1)	普化實戰解析(2)	Nernst 方程式	普化總複習(3)
(A)Page 16-7	Page C-3	第 32 題	普化實戰解析(3)	Page 62
(B)Page 11-47	KMU102(8)	完全相同	第 31 題	UST102A1&A5(60)
(C)Page 16-5	觀念相同		幾乎相同	幾乎相同
(D)(E)Page 16-9				
觀念相同				

第 66 題	第 67 題	第 68 題	第 69 題	第 70 題
滲透壓與 van't Hoff 因子 實力測驗 T4 Page 40 第 83 題 觀念類似	元素分析求簡式 普化總複習(2) Page D-6 GOV106(37) 完全命中	溫度單位換算 普化總複習(1) Page A-6 UST101A1&A5(19) 幾乎相同	平衡方程式係數 普化總複習(3) Page 109 UST102A1&A5(3) 幾乎相同	緩衝溶液計算 普化總複習(3) Page 89 NTU105B(24) 完全命中

第 71 題	第 72 題	第 73 題	第 74 題	第 75 題
氫鍵 普化總複習(3) Page 52 UST106A1(21) 完全命中	體心立方單位晶格中原子數量 普化總複習(1) Page B-10 UST97A5(33) 完全命中	偶極矩 普化總複習(3) Page 26 NTU104B(10) 幾乎相同	分子軌域與鍵長 普化總複習(3) Page 25 NTU104B(1) 幾乎相同	弱酸解離度計算 普化正課講義 Page 12-32 完全命中

第 76 題	第 77 題	第 78 題	第 79 題	第 80 題
Ksp 與 S 之計算 實力測驗 T6 Page 15 第 3 題 完全命中	寫核反應方程式 普化總複習(3) Page 120 NTU105B(29) 幾乎相同	有機化學 Mixed aldol 反應 有機總複習(1) Page C-11 UST106(16) 完全命中	Van't Hoff 方程式 普化正課講義 Page 11-53 完全命中 普化總複習(2) Page F-10 CMU 寒 105(16) 完全命中	化學計量 考古題 私醫 89(26) 觀念相同

第 81 題	第 82 題	第 83 題	第 84 題	第 85 題
氣體的平均分子量 考古題 義守 104(17) 幾乎相同	狀態函數種類 普化總複習(1) Page B-34 UST99A5(5) 完全命中	High、low spin 與電子是否成對 普化正課講義 Page 6-147 觀念相同	錯合物的 counterion 普化總複習(3) Page 44 TCUS106B(25) 完全命中	分子的磁性判斷 普化總複習(2) Page D-51 GOV106(44) 幾乎相同

第 86 題	第 87 題	第 88 題	第 89 題	第 90 題
波以耳定律的圖形 考古題 中國 91(24) 完全命中	SF_4 的鍵長 Line 首頁下載 Ch5-ch6 綜合考題(1)的第 28 題 觀念類似	Haber process 普化總複習(3) Page 79 NTU104C(13) NTU104C(14) 完全命中	酸鹼滴定 Line 首頁下載 Ch10-ch13 綜合考題(1)的第 20 題 完全命中	有機分子的 IUPAC 命名 普化總複習(3) Page 8 TCUS106B(22) 完全命中

16. Using the rules of significant figures, calculate the following: 0.102 × 0.0821 × 273/1.01

(A) 2.2635 (B) 2.264 (C) 2.26 (D) 2.3 (E) 2.66351

C

$$\frac{0.102 \times 0.0821 \times 273}{1.01} = 2.26352\ldots$$

(0.102: 3位; 0.0821: 3位; 273: 3位; 1.01: 3位)

取3位有效 → 2.26

---

17. Which of the following best describes an orbital?

(A) Space where electrons are likely to be found in an atom.
(B) Space which may contain electrons, protons, and/or neutrons.
(C) The space in an atom where an electron is most unlikely to be found.
(D) Small, walled spheres that contain electrons.
(E) A single space within an atom that contains all electrons of that atom.

A

原子核外的特定空間中，電子出現的機率較大的區域稱為軌域(orbital)

---

18. Which of the following is the correct electron configuration for OF^-?

(A) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}^2\,\pi_{2p}^2$
(B) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}^2\,\pi_{2p}^4\,\pi^*_{2p}{}^2$
(C) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}^2\,\sigma^*_{2s}{}^2\,\sigma_{2p}^2\,\pi_{2p}^4\,\pi^*_{2p}{}^4$
(D) $\sigma_{1s}^2\,\sigma^*_{1s}{}^2\,\sigma_{2s}^2\,\sigma^*_{2s}{}^2\,\pi_{2p}^1$
(E) None of the above.

C

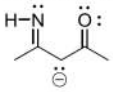
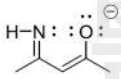
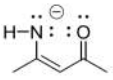
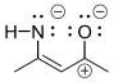
(1)兩個原子的電負度都相對大，沒有 mixing 現象
(2)O和F皆為第二週期元素
(3)價電子總數: 6 + 7 + 1 = 14

電子組態: $\sigma_{1s}^2\,\sigma^{*2}_{1s}\;\sigma_{2s}^2\,\sigma^{*2}_{2s}\,\sigma_{2p}^2\,\pi_{2p}^4\,\pi^{*4}_{2p}$

內層電子 / 價電子

---

19. Which of the following resonance structures is the most stable?

(A) 
(B) 
(C) 
(D) 
(E) All of them are the same.

B

共振貢獻式的穩定度判斷法則：
(1)化學鍵數量越多者，貢獻度越高 ⇒ (D)排除(化学键数量较少)

(2)鍵數相同，負電荷優先出現在高電負度原子上 ⇒ EN大小：O > N > C

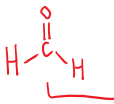
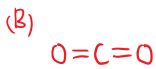
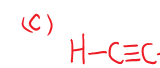
穩定度：(B) > (C) > (A)

---

20. Which of the following does **NOT** contain at least one pi bond?

(A) H_2CO (B) CO_2 (C) C_2H_2
(D) NO (E) All of the above (A-D) contain at least one pi bond.

E

(A)  (B)  (C)  (D) 

皆有 π-bond

21. Order the intermolecular forces (dipole-dipole, London dispersion, ionic, and hydrogen-bonding) from weakest to strongest.

B
(A) dipole-dipole, London dispersion, ionic, and hydrogen-bonding
(B) London dispersion, dipole-dipole, hydrogen-bonding, and ionic
(C) hydrogen-bonding, dipole-dipole, London dispersion, and ionic
(D) dipole-dipole, ionic, London dispersion, and hydrogen-bonding
(E) London dispersion, ionic, dipole-dipole, and hydrogen-bonding

粒子間作用力：分散力 < 偶極-偶極作用力 < 氫鍵 < 離子間作用力

---

22. Which separation technique is based on differences in the affinity of the substances to be separated?

D
(A) filtration (B) distillation (C) solvent extraction
(D) paper chromatography (E) None of the above.

層析法: 利用物質與固定相和移動相之間作用力不同而達到分離的技術

---

23. Which of the following gives correct rank of the ionization energies for Cs, Na, O, F, and S?

A
(A) Cs < Na < S < O < F (B) Cs < S < Na < O < F (C) F < O < Na < S < Cs
(D) F < O < S < Na < Cs (E) Na < S < Cs < F < O

游離能： F > O > S > Na > Cs

同週期: 8756423 1　同族: 正向下遞減　同族: 正向下遞減

---

24. Naturally occurring copper exists in two isotopic forms: ^{63}Cu and ^{65}Cu. The atomic mass of copper is 63.55 amu. What is the approximate natural abundance of ^{63}Cu?

E
(A) 63% (B) 90% (C) 80% (D) 85% (E) 72%

假設 ^{63}Cu 的自然含量為 Y，則：

$$63 \cdot Y + 65 \cdot (1-Y) = 63.55 \Rightarrow Y = 0.72$$

---

25. The correct mathematical expression for finding the molar solubility(s) of $Al(OH)_3$ is _____.

C
(A) $9s^2 = K_{sp}$ (B) $3s^3 = K_{sp}$ (C) $27s^4 = K_{sp}$ (D) $s^4 = K_{sp}$ (E) $9s^3 = K_{sp}$

$$Al(OH)_3 \rightarrow Al^{3+} + 3OH^-$$

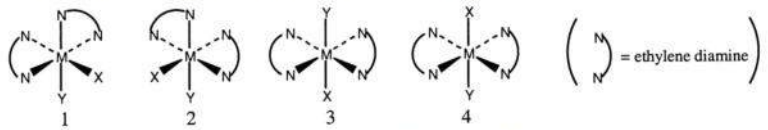
I:	solid	0	0
C:	-S	+S	+3S
E:	solid-S	S	3S

$\Rightarrow K_{sp} = S^1 \times (3S)^3 = 27S^4$

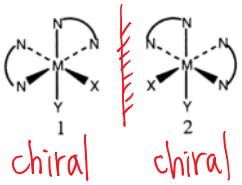
---

26. Consider the following octahedral complex structures, each involving ethylene diamine and two different, unidentate ligands X and Y. Which, if any, of the following pairs are optical isomers?

B



(A) 1 and 4 (B) 1 and 2 (C) 3 and 4
(D) 1 and 3 (E) None of the above.



Cpd 1 和 Cpd 2 有鏡像關係
但無法互相重疊
屬於光學異構物(optical isomer)

27. For which of the following processes would ΔS° be expected to be most positive?

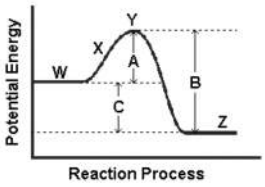
B

(A) $NH_3(g) + HCl(g) \rightarrow NH_4Cl(g)$
(B) $2NH_4NO_3(s) \rightarrow 2N_2(g) + O_2(g) + 4H_2O(g)$
(C) $H_2O(l) \rightarrow H_2O(s)$
(D) $N_2O_4(g) \rightarrow 2NO_2(g)$
(E) $O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$

(B)由固體進行化學反應變成 3 種不同氣體，此過程的 ΔS° 最大

28. Why is this reaction considered to be exothermic?

D

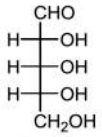


(A) Because energy difference A and energy difference C are about equal.
(B) Because energy difference B is greater than energy difference C plus energy difference A.
(C) Because energy difference A is greater than energy difference C.
(D) Because energy difference B is greater than energy difference A.
(E) Because energy difference B is greater than energy difference C.

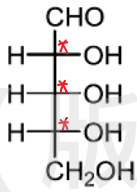
逆反應的活化能B大於正反應的活化能A
表示產物Z的位能比起始物W的位能更低，屬於放熱反應

29. The structure of pentose is shown on the down figure. How many carbon atoms with chirality are there in this molecule?

C



(A) 1 (B) 2 (C) 3 (D) 4 (E) 5



共有3個 chiral center

30. Which one is Bragg equation?

C

(A) $F = ma$ (B) $H\phi = E\phi$ (C) $n\lambda = 2d\sin\theta$ (D) $\Delta x \cdot \Delta p = h$ (E) $E = mc^2$

(A)牛頓第二運動定律
(B)薛丁格波動方程式
(C)布拉格定律
(D)海森堡的測不準原理
(E)愛因斯坦的質能互換公式