

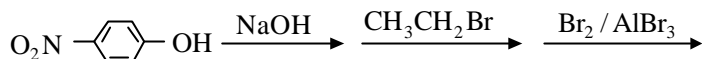
# 高雄醫學大學九十一學年度學士後西醫學系招生考試試題

## 科目：化學

I. Choose one correct answer for the following questions, 40%

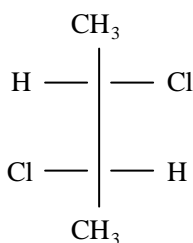
說明：每題選出一個最適當的選項，標示在答案卡上。每題答對得 2 分，答錯倒扣 0.5 分，未作答者，不給分亦不扣分。

(C) 1. What is the final product for the following reaction sequence?



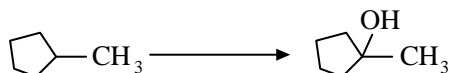
- (A) 3-bromo-6-ethyl-4-nitrophenol (B) 6-bromo-2-ethyl-4-nitrophenol  
 (C) 2-bromo-1-ethoxy-4-nitrobenzene (D) 2-bromo-1-ethylphenol  
 (E) 4-bromonitrotoluene

(C) 2. Please give the correct name for the following structure.



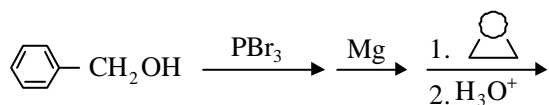
- (A) (R,S)-2,3-dichlorobutane (B) (2R,3S)-2,3-dichlorobutane  
 (C) (2S,3S)-2,3-dichlorobutane (D) (2R,3R)-2,3-dichlorobutane (E) 1,2-dichloroethane

(C) 3. Which of the following reagents can be used to carry out the following transformation?



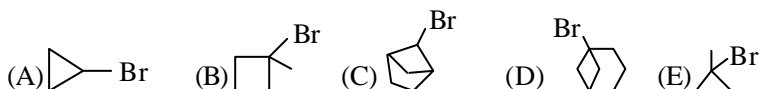
- (A)  $\text{H}_2\text{O}/\text{H}^+$  (B) 1.  $\text{KMnO}_4$ , 2.  $\text{H}_2\text{O}$  (C) 1.  $\text{Br}_2$ ,  $h\nu$ , 2.  $\text{H}_2\text{O}$  (D) 1.  $\text{Na}$ , 2.  $\text{H}_2\text{O}/\text{H}^+$   
 (E)  $\text{NaOH}$

(E) 4. The final product for the reaction sequence below is

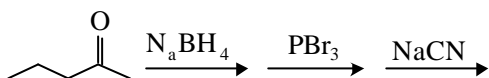


- (A)  $\text{PhCH}_2\text{OEt}$  (B)  $\text{PhCH}_2\text{OH}$  (C)  $\text{Ph}(\text{CH}_2)_2\text{Br}$  (D)  $\text{Ph}(\text{CH}_2)_2\text{OEt}$  (E)  $\text{Ph}(\text{CH}_2)_3\text{OH}$

(D) 5. Which of the following compounds does not undergo both  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$  reaction?



(B) 6. What is the final product for the following sequence of reaction below?



- (A) 2-methyl-1-pentanol (B) 2-methylpentanenitrile (C) acetonitrile (D) 2-pentanamine  
(E) 2-bromo-2-cyano-pentanol

(E) 7. (S)(+)-Butanol shows a specific rotation at  $+13.52^\circ$ . What is the ratio of (S)(+)-Butanol and (R)(-)-butanol when the measured rotation equals to  $+6.76^\circ$ ?

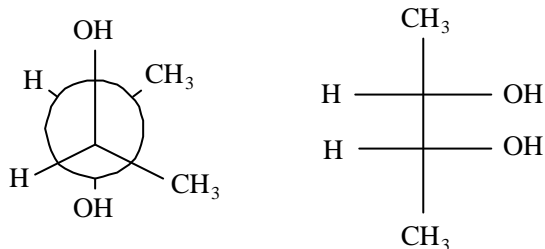
- (A) (S):(R) = 4:1 (B) (S):(R) = 2:1 (C) (S):(R) = 1:2 (D) (S):(R) = 1:2.5  
(E) (S):(R) = 3:1

(D) 8. Calculate the  $\Delta G$  for the reaction,  $2\text{SO}_2(\text{g}) + \text{O}_2 \rightarrow 2\text{SO}_3(\text{g})$

$$\Delta G_f^\circ: \text{SO}_2 = -300.4 \text{ kJ/mol}; \text{SO}_3 = -370.4 \text{ kJ/mol}$$

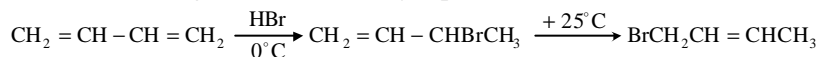
- (A)  $-70.0 \text{ kJ}$  (B)  $+70.7 \text{ kJ}$  (C)  $-670.8 \text{ kJ}$  (D)  $-140.0 \text{ kJ}$  (E)  $+140.0 \text{ kJ}$

(B) 9. Which of the following terms best describes the pair of compound shown:



- (A) enantiomers (B) diastereomers (C) meso compounds (D) same compound  
(E) threo-erythro isomer

(A) 10. For the following reactions the major products are shown:



These provide an example of (I) control at low temperature and (II) control at high temperature.

(I) (II)

- (A) kinetic thermodynamic  
(B) thermodynamic kinetic  
(C) kinetic kinetic  
(D) thermodynamic thermodynamic  
(E) none of these

(C) 11. The number of possible dichloronitrobenzene isomers is

- (A) 3 (B) 4 (C) 6 (D) 8 (E) 9

(B) 12. Which of the following compounds has a double bond that is conjugated with the  $\pi$  system of the benzene ring?

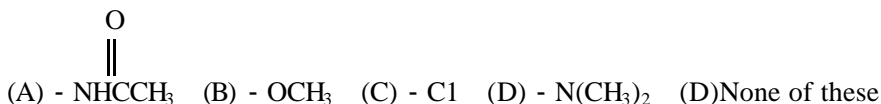
- (A) p-Benzyltoluene (B) 2-Phenyl-1-decene (C) 3-Phenylcyclohexene  
(D) 3-Phenyl-1,4-pentadiene (E) None of these

(C) 13. Consider the following statements concerning the effect of a trifluoromethyl group- $\text{CF}_3$ , on an electrophilic aromatic substitution. Which of these statements is (or are) correct?

- The  $\text{CF}_3$  group will activate the ring.
- The  $\text{CF}_3$  group will deactivate the ring.
- The  $\text{CF}_3$  group will be a meta director.
- The  $\text{CF}_3$  group will be an ortho, para director.

- (A) 1,3 (B) 1,4 (C) 2,3 (D) 2,4 (E) 3,4

(C) 14. All the following groups are activating ortho, para directors when attached to a benzene ring EXCEPT



(B) 15. The <sup>1</sup>H nmr spectrum of acetone consists of a singlet with a chemical shift of 2.07 ppm. What was the spectrometer frequency of the instrument used if this chemical shift equaled 186Hz?

(A) 60MHz (B) 90MHz (C) 100MHz (D) 120MHz (E) Need more information to determine

(D) 16. The following problem refers to the <sup>1</sup>H nmr spectrum of CH<sub>3</sub>CH<sub>2</sub>OCH<sub>2</sub>OCH<sub>2</sub>CH<sub>3</sub>.

(A) 12 (B) 5 (C) 4 (D) 3 (E) 6

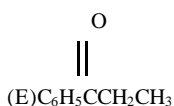
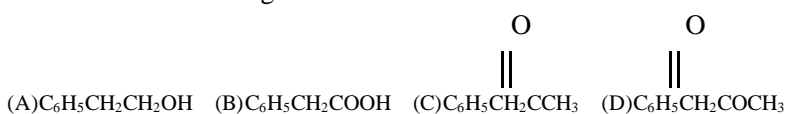
(B) 17. The relationship between magnetic field strength and the energy difference between nuclear spin states is:

(A) They are independent of each other. (B) They are directly proportional.

(C) They are inversely proportional. (D) Their relationship varies from molecule to molecule.

(E) None of these.

(B) 18. An infrared spectrum exhibits a broad band in the 3000 to 3500cm<sup>-1</sup> region and a strong peak at 1710cm<sup>-1</sup>. Which of the following substances best fits the data?



(C) 19. Which (if any) of the following would not be classified as an organometallic substance?

(A) Triethylaluminum (B) Ethylmagnesium iodide (C) Potassium *tert*-butoxide

(D) None of these (all are organometallic compounds) (E) All of these.

(A) 20. Rank the following species in order of increasing polarity of the carbon-metal bond (least → most polar):



A                      B                      C

(A) C < A < B (B) B < A < C (C) A < C < B (D) B < C < A (E) A < B < C

II. Choose one correct answer for the following questions, 60%

說明：每題選出一個適當的選項，標示在答案卡上。每題答對得 1 分，答錯倒扣 0.25 分，未作答者，不給分亦不扣分。

(B) 21. How many electrons in an atom can have of the following quantum number or sublevel designations? (choosing the correct answers)

(I) n = 2, l = 1. (II) 3d. (III) 4s. (IV) 4p. (V) n = 3, l = 1, m<sub>l</sub> = 1. (VI) n = 5, l = 3.

(A) (I) + (II) = 15e<sup>-</sup> (B) (III) + (IV) = 8e<sup>-</sup> (C) (V) + (VI) = 15e<sup>-</sup>

(D) (I) + (II) + (V) = 10e<sup>-</sup> (E) (II) + (IV) + (VI) = 28e<sup>-</sup>

(D) 22. Of the following sets of four quantum numbers, identify the ones that can exist for an electron in an atom?

(A) n = 1, l = 1, m<sub>l</sub> = 0, m<sub>s</sub> = 1/2. (B) n = 2, l = 0, m<sub>l</sub> = ±1, m<sub>s</sub> = 1/2.

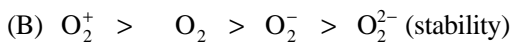
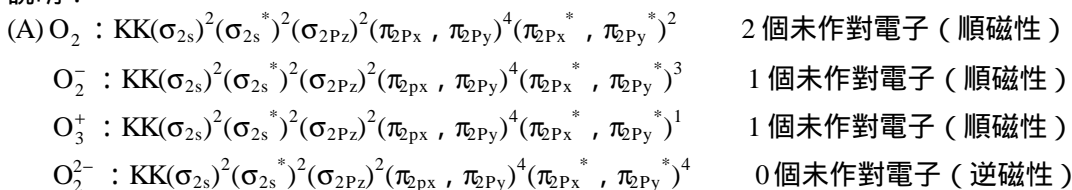
(C) n = 3, l = 3, m<sub>l</sub> = ±3, m<sub>s</sub> = -1/2. (D) n = 4, l = 3, m<sub>l</sub> = ±2, m<sub>s</sub> = 1/2.

(E) n = 4, l = 4, m<sub>l</sub> = -1, m<sub>s</sub> = 1/2.

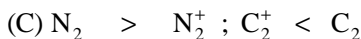
- (無)23. How many valence electrons in an element can have for each of the following species? (choosing the correct answers)  
 (I)P<sup>3+</sup> (II)Rh<sup>2+</sup> (III)Co<sup>4+</sup> (IV)Mn<sup>3+</sup> (V)Ni<sup>2+</sup> (VI)Si<sup>2+</sup> (VII)Sb (VIII)B<sup>1+</sup>  
 (A)(I) + (III) = 8e<sup>-</sup> (B)(II) + (VI) = 8e<sup>-</sup> (C)(III) + (VII) = 9e<sup>-</sup>  
 (D)(I) + (IV) + (VIII) = 6e<sup>-</sup> (E)(II) + (V) + (VII) = 18e<sup>-</sup>  
 説明：(I)P<sup>3+</sup>([Ne]3S<sup>2</sup>) ; (II)Rh<sup>2+</sup>([Kr]4d<sup>7</sup>) ; (III)Co<sup>4+</sup>([Ar]3d<sup>5</sup>) ; (IV)Mn<sup>3+</sup>([Ar]3d<sup>4</sup>) ;  
 (V)Ni<sup>2+</sup>([Ar]3d<sup>8</sup>) ; (VI)Si<sup>2+</sup>([Ne]3S<sup>2</sup>) ; (VII)Sb([Kr]4d<sup>10</sup>5S<sup>2</sup>5P<sup>3</sup>) ; (VIII)B<sup>1+</sup>([He]2S<sup>2</sup>)
- (C) 24. Which of the following statements is not correct?  
 (A) According to the VSEPR theory, the I<sup>3-</sup> molecule is predicted to be linear.  
 (B) According to the VSEPR theory, the InF<sub>4</sub><sup>1-</sup> molecule is predicted to be tetrahedral.  
 (C) According to the VSEPR theory, the GeBr<sub>3</sub><sup>1-</sup> molecule is predicted to be trigonal planar  
 (D) According to the VSEPR theory, the CII<sub>3</sub> molecule is predicted to be T-shaped.  
 (E) According to the VSEPR theory, TeS<sub>3</sub><sup>2-</sup> molecule is predicted to be pyramidal.
- (E) 25. Suppose the hypothetical set of quantum numbers:  
 n = 1, 2, 3, .....  
 i = 0, 1, 2, 3, .....n - 1  
 m = 1  
 s = 1/2, -1/2  
 then which of the following statements is not correct?  
 (A) The is one s orbital, one p orbital, and d orbital.  
 (B) The atomic number of the first element in the d-fillers is 12.  
 (C) There are two transition elements in the first period.  
 (D) The atomic number of the first inert gas is 2.  
 (E) If one element has the atomic number 14, then its electron configuration is Is<sup>2</sup>2s2p<sup>2</sup>3s<sup>2</sup>ep<sup>2</sup>.
- (C) 26. Arrange in decreasing order of stability of the following four isomers.  
 (I) *cis*-1-chloro-2-methylcyclohexane  
 (II) *trans*-1-chloro-2-methylcyclohexane  
 (III) *cis*-1-chloro-3-methylcyclohexane  
 (IV) *trans*-1-chloro-3-methylcyclohexane  
 (A)(II) > (III) > (I) > (IV) (B)(I) > (II) > (IV) > (III) (C)(III) > (II) > (IV) > (I)  
 (D)(IV) > (II) > (I) > (III) (E) none of the above.
- (C) 27. Diastereomers have the same  
 (A) melting point. (B) reaction rate toward optically active reagent. (C) molecular weight.  
 (D) stereochemistry at each chiral center. (E) specific rotation.
- (C) 28. Which of the following statements is correct?  
 (A) A structure with two chiral centers will always give rise to four stereoisomers  
 (B) Molecules that contain chiral carbons must be optically active compounds.  
 (C) Equimolar mixtures of two enantiomers are called racemate.  
 (D) Distereomers have same physical properties. (E) none of the above.
- (C) 29. Who characterized alpha, beta and gamma radiation?  
 (A) Thomson (B) Einstein (C) Rutherford (D) Heisenberg (E) Bohr
- (C) 30. Of the following sets of four quantum numbers, identify the ones that can exist for an electron in an atom?  
 (A)(5, 4, 5, +1/2) (B)(2, 2, -1, +1/2) (C)(3, 2, 2, +1/2) (D)(6, 7, 0, +1/2)  
 (E)(2, 0, -2, +1/2)
- (C) 31. How many constitutional isomers are there for C<sub>5</sub>H<sub>11</sub>Br?  
 (A)3 (B)7 (C)8 (D)10 (E)11.

- (D) 32. Which of the following statements correctly describes an achiral molecule?  
 (A) The molecule has a nonsuperimposable mirror image.  
 (B) The molecule exhibits optical activity when it interacts with plane-polarized light.  
 (C) The molecule has an enantiomer. (D) The molecule might be a meso form.  
 (E) None of the above.
- (B) 33. Which of the following molecules has the highest bond order?  
 (A) BN (B) CO (C) NO (D) Ne<sub>2</sub> (E) F<sub>2</sub>
- (D) 34. According to the VSEPR theory, which of the following statements is correct?  
 (A) The expected geometry of TeO<sub>3</sub><sup>2-</sup> is trigonal planar.  
 (B) The expected geometry of SbBr<sub>4</sub><sup>3-</sup> is tetrahedral.  
 (C) The expected geometry of SeS<sub>2</sub><sup>4-</sup> is bent.  
 (D) The expected geometry of BiCl<sub>3</sub> is pyramidal.  
 (E) The expected geometry of SnI<sub>4</sub><sup>2-</sup> is square planar.
- (A B C) 35. Which of the following statements is correct?  
 (A) In O<sub>2</sub>, O<sub>2</sub><sup>2-</sup>, O<sub>2</sub><sup>-</sup>, and O<sub>2</sub><sup>+</sup> species, only the O<sub>2</sub><sup>2-</sup> molecule is diamagnetic.  
 (B) The stability decreases in the order O<sub>2</sub><sup>+</sup> > O<sub>2</sub> > O<sub>2</sub><sup>-</sup> > O<sub>2</sub><sup>2-</sup>  
 (C) The dissociation energy of N<sub>2</sub> is larger than that of N<sub>2</sub><sup>+</sup>, while the dissociation energy of C<sub>2</sub><sup>+</sup> is smaller than that of C<sub>2</sub>.  
 (D) In Mn<sup>2+</sup>, Cr<sup>3+</sup>, Hg<sup>2+</sup>, V<sup>3+</sup>, Ni<sup>2+</sup>, and La<sup>3+</sup> six transition metal ions, only Mn<sup>2+</sup>, V<sup>3+</sup>, and La<sup>3+</sup> are paramagnetic.  
 (E) The atom size increases in the order K<sup>+</sup> > Cl<sup>-</sup> > S<sup>2-</sup>, while the atom size of Au<sup>+</sup> is larger than that of Au<sup>3+</sup>.

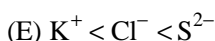
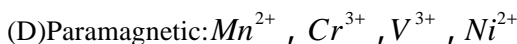
說明：



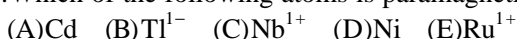
$$\text{B.O.} = 2.5 \quad 2 \quad 1.5 \quad 1$$



$$\text{B.O.} = 3 \quad 2.5 \quad 1.5 \quad 2$$



- (D) 36. Which of the following atoms is paramagnetic?



- (A D) 37. Which of the following statements is not true?

(A) *trans*-1,3-dimethylcyclohexane is more stable than *cis*-1,3-dimethylcyclohexane.

(B) *trans*-1,2-dimethylcyclohexane is more stable than *cis*-1,2-dimethylcyclohexane.

(C) *trans*-1,4-dimethylcyclohexane is more stable than *cis*-1,4-dimethylcyclohexane.

(D) *trans*-1,2-dimethylcyclohexane is more stable than *cis*-1,3-dimethylcyclohexane.

(E) *trans*-1,2-dimethylcyclohexane is less stable than *cis*-1,3-dimethylcyclohexane.

說明：Stability: *trans*-1,4-

*cis*-1,4-

>*trans*-1,2->

>*cis*-1,2-Dimethylcyclohexane

*cis*-1,3-

*trans*-1,3-

- (B) 38. The approximate  $pK_a$  of  $NH_3$  is 36; that of  $C_2H_5OH$  is 16. From this information, which (if any) of the following conclusion is (or are) correct?  
 (A) The conjugate base of  $C_2H_5OH$  is stronger. (B) The conjugate base of  $NH_3$  is stronger.  
 (C)  $C_2H_5OH$  is a weaker acid than  $NH_3$  (D) None of these is correct.  
 (E) All of these are correct.
- (C) 39. The activation energy ( $E_{act}$ ) of a given reaction is unrelated to which of the following parameters?  
 (A) The rate of the slowest step of a multistep reaction.  
 (B) The rate of the overall reaction.  
 (C) The heat absorbed or given off by the reaction ( $\Delta H$ )  
 (D) The stability of the transition state. (E) None of these.
- (D) 40. Which of the following is least able to serve as a nucleophile in a chemical reaction?  
 (A)  $Br^-$  (B)  $OH^-$  (C)  $NH_3$  (D)  $CH_3^+$  (E)  $I^-$
- (A) 41. Thiols are alcohol analogs in which the oxygen has been replaced by sulfur (e.g.,  $CH_3SH$ ). Given the fact that the S-H bond is less polar than the O-H bond, which of the following statements comparing thiols and alcohols is correct?  
 (A) Hydrogen bonding forces are weaker in thiols.  
 (B) Hydrogen bonding forces are stronger in thiols  
 (C) Hydrogen bonding forces would be the same.  
 (D) No comparison can be made without additional information.  
 (E) None of these.
- (C) 42. Rank the transition states which occur during the following reaction steps in order of increasing stability (least  $\rightarrow$  most stable):  
 (a)  $CH_3 - OH_2^+ \rightarrow CH_3^+ + H_2O$   
 (b)  $(CH_3)_3C - OH_2^+ \rightarrow (CH_3)_3C^+ + H_2O$   
 (c)  $(CH_3)_2CH - OH_2^+ \rightarrow (CH_3)_2CH^+ + H_2O$   
 (A)  $a < b < c$  (B)  $b < c < a$  (C)  $a < c < b$  (D)  $b < a < c$  (E)  $c < b < a$
- (C) 43. An alkane with a molecular formula  $C_6H_{14}$  reacts with chlorine in the presence of light and heat. Four constitutionally isomeric monochlorides of molecular formula  $C_6H_{13}Cl$  are formed (along with a mixture of dichlorides, trichlorides, and so on). What is the most reasonable structure for the starting alkane?  
 (A)  $CH_3CH_2CH_2CH_2CH_2CH_3$  (B)  $(CH_3)_2CHCH_2CH_2CH_3$  (C)  $CH_3CH(CH_2CH_3)_2$   
 (D)  $(CH_3)_3CCH_2CH_3$  (E)  $(CH_3)_2CHCH(CH_3)_2$
- (C) 44. Carboxylic acids exist in the vapor state as:  
 (A) Monomeric species (B) Cyclic esters (C) Cyclic dimers (D) Cyclic trimers  
 (E) None of these
- (A) 45. The product from the reaction of 1-pentene with  $Cl_2$  in  $H_2O$  is named:  
 (A) 1-Chloro-2-pentanol (B) 2-Chloro-2-pentanol (C) 1-Chloro-1-pentanol  
 (D) 2-Chloro-1-pentanol (E) none of these
- (C) 46. In the reaction of a reagent such as  $HBr$  with an alkene, the first step of the reaction is the \_\_\_\_\_ to the alkene.  
 (A) Fast addition of an electrophile (B) Fast addition of a nucleophile  
 (C) Slow addition of an electrophile (D) Slow addition of a nucleophile (E) none of these
- (D) 47. Markovnikov's rule "works" because:  
 (A) The most stable transition state is the one leading to the more substituted carbocation.  
 (B) The nucleophile adds during the second step of the ionic reaction.  
 (C) The electrophile adds to the less substituted end of the double bond.  
 (D) All of these are true. (E) All of these are not true.

- (B) 48. Treatment of 2-methyl-2-butene with HBr in the presence of peroxide yields  
 (A) A primary alkyl bromide (B) A secondary alkyl bromide (C) A tertiary alkyl bromide  
 (D) A vicinal dibromide (E) None of these
- (D) 49. The strongest evidence for the formation of a bridged bromonium ion as an intermediate in the addition of Br<sub>2</sub> to an alkene is:  
 (A) Markovnikov's rule (B) Zaitsev's rule (C) The regioselectivity of the reaction  
 (D) The stereospecificity of the reaction (E) None of these
- (D) 50. A compound having a molecular formula of C<sub>20</sub>H<sub>36</sub> is inert to catalytic hydrogenation. Which of the following statements is true?  
 (A) The substance has at least one double bond and two rings.  
 (B) The substance is acyclic (i.e., no rings are present) (C) The substance has two rings.  
 (D) The substance has three rings. (E) None of these.
- (B) 51. The bimolecular substitution reaction  

$$\text{CH}_3\text{Br} + \text{OH}^- \rightarrow \text{CH}_3\text{OH} + \text{Br}^-$$
 is represented by the kinetic equation:  
 (A) Rate = k[CH<sub>3</sub>Br]<sup>2</sup> (B) Rate = k[CH<sub>3</sub>Br][OH<sup>-</sup>] (C) Rate = k[CH<sub>3</sub>Br] + k[OH<sup>-</sup>]  
 (D) Rate = k[CH<sub>3</sub>Br][OH<sup>-</sup>] (E) Rate = k[CH<sub>3</sub>Br]<sup>2</sup> + k[OH<sup>-</sup>]
- (B) 52. The solvolysis reactions of optically active halides generally proceed with  
 (A) Complete racemization (B) Partial racemization (C) complete retention of configuration  
 (D) Complete inversion of configuration (E) None of these
- (C) 53. Which of the following statements pertaining to an S<sub>N</sub>2 reaction are true?  
 1. The rate of reaction is independent of the concentration of the nucleophile.  
 2. The nucleophile attacks carbon on the side of the molecule opposite the group being displaced.  
 3. The reaction proceeds with simultaneous bond formation and bond rupture.  
 4. Partial racemization of an optically active substrate results.  
 (A) 1,4 (B) 1,3,4 (C) 2,3 (D) 1,3 (E) All
- (A) 54. Which of the following phrases are not correctly associated with S<sub>N</sub>1 reactions?  
 1. Rearrangements possible  
 2. Rate affected by solvent polarity  
 3. Strength of nucleophile important in determining rate  
 4. Reactivity series tertiary > secondary > primary  
 5. Proceed with complete inversion of configuration  
 (A) 3,5 (B) 1,5 (C) 2,3,5 (D) 3 only (E) 4,5
- (D) 55. Which of the following statements is true concerning pK<sub>a</sub>?  
 (A) The larger the pK<sub>a</sub> value, the weaker the acid. (B) Strong acids have small pK<sub>a</sub> values. (C) pK<sub>a</sub> = -log K<sub>a</sub>  
 (D) All the statements are correct. (E) All the statements are incorrect.
- (A) 56. Referring to the following equilibrium (R=alkyl group)  

$$\text{RCH}_2\text{CH}_3 + \text{RC}=\text{C} \rightleftharpoons \text{RCH}_2\text{CH}_2^- + \text{RC}=\text{C}-\text{H}$$
 (A) K < 1 ; the equilibrium would lie the left.  
 (B) K > 1 ; the equilibrium would lie the right.  
 (C) K = 1 ; equal amounts of all species would be present.  
 (D) Not enough information is given; the structure of R must be known.  
 (E) None of these
- (B) 57. Which alkyne yields butanoic acid (CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CO<sub>2</sub>H) as the only organic product upon treatment with ozone followed by hydrolysis?  
 (A) 1-Butyne (B) 4-Octyne (C) 1-Pentyne (D) 2-Hexyne (E) None of these

- (B) 58. Which of the following produces a significant amount of acetylide ion on reaction with acetylene?  
 (A) Conjugate base of  $\text{CH}_3\text{OH}$  ( $\text{p}K_a$  16) (B) Conjugate base of  $\text{H}_2$  ( $\text{p}K_a$  35)  
 (C) Conjugate base of  $\text{H}_2\text{O}$  ( $\text{p}K_a$  16) (D) Both (A) and (C) (E) Both (A) and (B)
- (A) 59. Hydrogenation of cyclohexene releases 120 kJ/mol of heat. Which of the following most likely represents the observed heat of hydrogenation of 1,3-cyclohexadiene?  
 (A) 232 kJ/mol (B) 239 kJ/mol (C) 247 kJ/mol (D) 120 kJ/mol (E) 142 kJ/mol
- (A) 60. Arrange the following intermediates in order of decreasing basicity (strongest  $\rightarrow$  weakest):  
 $\text{CH}_2 = \text{CHNa}$        $\text{CH}_3\text{CH}_2\text{Na}$        $\text{CH}_3\text{CH}_2\text{ONa}$        $\text{HC} \equiv \text{CNa}$   
                           A                            B                            C                            D  
 (A)  $\text{B} > \text{A} > \text{D} > \text{C}$  (B)  $\text{D} > \text{A} > \text{B} > \text{C}$  (C)  $\text{C} > \text{D} > \text{A} > \text{B}$  (D)  $\text{C} > \text{B} > \text{D} > \text{A}$   
 (E)  $\text{D} > \text{C} > \text{B} > \text{A}$
- (B) 61. Give the major product of the following reaction: (E)-2-pentene +  $\text{CH}_2\text{I}_2/\text{Zn}(\text{Cu}) \rightarrow ?$   
 (A) *cis*-1-Ethyl-2-methylcyclopropane (B) *trans*-1-Ethyl-2-methylcyclopropane  
 (C) 1-Ethyl-1-methylcyclopropane (D) An equimolar mixture of product (A) and (B)  
 (E) None of these
- (D) 62. Which of the following would yield a secondary alcohol after the indicated reaction, followed by aqueous hydrolysis if necessary?  
 (A)  $\text{LiAlH}_4$  + a ketone (B)  $\text{CH}_3\text{CH}_2\text{MgBr}$  + an aldehyde  
 (C) 2-Butene + mercury(II) acetate, then  $\text{NaBH}_4$ , HO  
 (D) All of these (E) None of these
- (C) 63. Which of the esters shown, after reduction with  $\text{LiAlH}_4$  and aqueous workup, will yield two molecules of only a single alcohol?  
 (A)  $\text{CH}_3\text{CH}_2\text{CO}_2\text{CH}_2\text{CH}_3$  (B)  $\text{C}_6\text{H}_5\text{CO}_2\text{C}_6\text{H}_5$  (C)  $\text{C}_6\text{H}_5\text{CO}_2\text{CH}_2\text{C}_6\text{H}_5$  (D) None of these  
 (E) All of these
- (B) 64. For the following reaction, select the statement which best describes the situation.  
 $\text{RCH}_2\text{OH} + (\text{C}_5\text{H}_5\text{N})_2\text{CrO}_3 \rightarrow$   
 (A) The alcohol is oxidized to an acid, and the Cr (VI) is reduced.  
 (B) The alcohol is oxidized to an aldehyde, and the Cr (VI) is reduced.  
 (C) The alcohol is reduced to an aldehyde, and the Cr (III) is oxidized  
 (D) The alcohol is oxidized to a ketone, and the Cr (VI) is reduced.  
 (E) The alcohol is oxidized to an acid, and the Cr (III) is reduced.
- (A) 65. Which of the following alcohols gives the best yield of dialkyl ether on being heated with a trace of sulfuric acid?  
 (A) 1-Pentanol (B) 2-Pentanol (C) Cyclopentanol (D) 2-Methyl-2-butanol  
 (E) 2-Ethyl-propanol
- (A) 66. The most effective pair of reagents for the preparation of tert-butyl ethyl ether is:  
 (A) Potassium tert-butoxide and ethyl bromide (B) Potassium tert-butoxide and ethanol  
 (C) Sodium ethoxide and tert-butyl bromide (D) tert-Butyl alcohol and ethyl bromide  
 (E) None of these
- (D) 67. Heating a particular ether with HBr yielded a single organic product. Which of the following conclusions may be reached?  
 (A) The reactant was a methyl ether. (B) The reactant was a symmetrical ether.  
 (C) The reactant was a cyclic ether. (D) Both (B) and (C) are correct  
 (E) Both (A) and (B) are correct
- (C) 68. In the  $^1\text{H}$  NMR spectrum of  $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$ , how many signals are expected?  
 (A) 3 (B) 4 (C) 5 (D) 6 (E) 7



- (B) 69. Ionization energies are  
 (A) always negative (B) always positive (C) usually positive but sometimes negative  
 (D) usually negative but sometimes positive (E) usually zero
- (E) 70. Rank the following in order of increasing size: Cl, Cl<sup>+</sup>, Cl<sup>-</sup>  
 (A) Cl < Cl<sup>+</sup> < Cl<sup>-</sup> (B) Cl < Cl<sup>-</sup> < Cl<sup>+</sup> (C) Cl<sup>-</sup> < Cl < Cl<sup>+</sup> (D) Cl<sup>+</sup> < Cl<sup>-</sup> < Cl (E) Cl<sup>+</sup> < Cl < Cl<sup>-</sup>
- (C) 71. When carbon bonds to chlorine, the bond will be \_\_\_\_\_ and \_\_\_\_\_ atom bears a partial negative charge.  
 (A) nonpolar, neither (B) polar, the carbon (C) polar, the chlorine (D) nonpolar, the carbon  
 (E) nonpolar, the chlorine
- (B) 72. Which of the following is (or are) the rate law for a reaction that is first order in oxygen?  
 (A) rate = k[NO<sub>2</sub>] (B) rate = k[NO<sub>2</sub>][O<sub>2</sub>] (C) rate = k[NO<sub>2</sub>]<sup>2</sup> / [O<sub>2</sub>]  
 (D) rate = k[NO<sub>2</sub>]<sup>2</sup> / ([O<sub>2</sub>][N<sub>2</sub>]) (E) All of the above
- (C) 73. When a catalyst is added to a reaction system, \_\_\_\_\_  
 (A) the equilibrium position is changed (B) the enthalpy is changed (C) the rate is changed  
 (D) all of the above (E) none of the above
- (C) 74. Which of the following is not aromatic?  
 (A) pyridine (B) furan (C) cyclobutadiene (D) benzene (E) annulene

說明：annulene { [6], [14], [18], 及[22]annulene 為芳香性  
 [4], [8], [10], [12], [16], 及[20]不是芳香性

- (A) 75. Which sub-shell can hold the greatest number of electrons?  
 (A) 3d (B) 3p (C) 4p (D) 5p (E) 5s
- (D) 76. In the Lewis structure of ozone, the central oxygen atom has  
 (A) 1 lone pair and 4 bonding pairs of electrons  
 (B) 1 lone pair and 2 bonding pairs of electrons  
 (C) 2 lone pair and 2 bonding pairs of electrons  
 (D) 1 lone pair and 3 bonding pairs of electrons (E) 2 lone pairs of electrons
- (C) 77. What type of orbitals best describes the bond between the two oxygen atoms in H-O-O-SO<sub>3</sub>?  
 (A) sp-sp (B) sp<sup>2</sup>-sp<sup>2</sup> (C) sp<sup>3</sup>-sp<sup>3</sup> (D) s-s (E) 2p<sub>x</sub>-2p<sub>x</sub>
- (D) 78. Consider the following reaction: 3H<sub>2</sub>(g) + N<sub>2</sub>(g) ↔ 2NH<sub>3</sub>(g). All of the following will lead to the production of more NH<sub>3</sub>(g) EXCEPT  
 (A) removal of NH<sub>3</sub>(g) (B) a decrease in the volume of the container  
 (C) an increase in pressure by adding N<sub>2</sub>(g) (D) an increase in pressure by adding argon  
 (E) addition of H<sub>2</sub>(g)
- (C) 79. The conjugate acid of ammonia is  
 (A) NH<sub>2</sub><sup>-</sup> (B) NH<sub>2</sub>OH (C) NH<sub>4</sub><sup>+</sup> (D) HO<sup>-</sup> (E) NH<sub>3</sub>
- (C) 80. Which of the following conditions will result in a spontaneous reaction at all temperatures?  
 (A) ΔH < 0, ΔS < 0 (B) ΔH > 0, ΔS < 0 (C) ΔH < 0, ΔS > 0 (D) ΔH > 0, ΔS > 0  
 (E) ΔH > 0, ΔS = 0