# 國立中興大學113學年度

# 學士後醫學系公費生招生考試

# 化學科試題

## 考試時間：100分鐘

**考試開始鈴響前，不得翻閱試題，且不得書寫、畫記、作答!**
**本考試不得使用計算機**

考生請注意：

一、考生應確實關閉行動電話(或取出電池)及手錶之鬧鈴設定；除准考證及考試必需用品外，所有物品(含行動電話、穿戴式裝置等)均應立即放置於臨時置物區，不得發出聲響或有影響試場秩序之情形。

二、請確認抽屜中、桌椅下、座位旁均無其他非必要用品。如有任何問題請立即舉手反映。

三、坐定後，雙手離開桌面，請核對並確認准考證、座位標籤、及答案卡上之准考證號碼是否完全相同。如有錯誤，應立即舉手請監試人員處理。

四、考生應試時不得飲食、飲水、抽菸、嚼食口香糖。

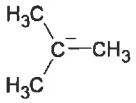
五、答案卡劃記以2B鉛筆為佳，劃記時要粗黑、清晰，劃滿作答格，不可出格，不得折損答案卡，修正作答以軟性橡皮擦擦拭乾淨，且不得使用修正液(帶)修正，未遵照正確作答方式而致機器無法正確辨識答案者，考生自行負責，不得以任何理由補救。答案寫在試題紙上者不予計分。

六、本試題必須與答案卡一併繳回，不得攜出試場。

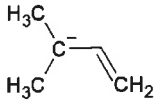
選擇題（單選）每題2分，共50題100分，答錯倒扣0.5分，倒扣至0分為止：

1. Please determine the more stable anion in each of the following cases: (i), (ii), and (iii).

(i)

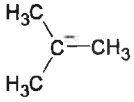


a

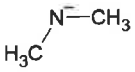


b

(ii)

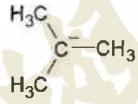


c

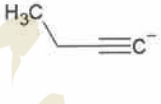


d

(iii)



e

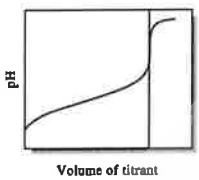


f

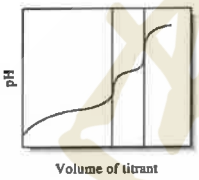
(A) a, c, f
(B) a, d, f
(C) b, d, f
(D) b, d, e
(E) a, c, e

2. When a solution of 0.1 M $Na_2CO_3$/0.1 M $NaHCO_3$ ($H_2CO_3$: $K_{a1} = 4.2 \times 10^{-7}$ and $K_{a2} = 4.69 \times 10^{-11}$) is titrated with 0.1 M HCl. Which one is the titration curve?

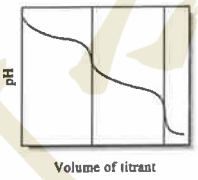
(A)



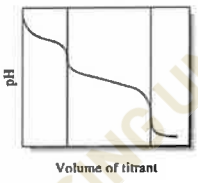

(B)



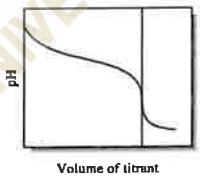

(C)



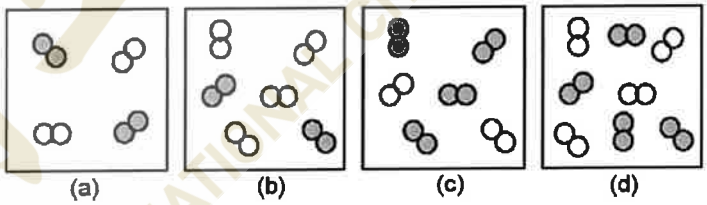

(D)




(E)




3. The relative initial rates of the reaction $X_2 + Y_2 \rightarrow$ products in vessels (a)-(d) follow a ratio of 1:8:2:16. Unshaded spheres depict $X_2$ molecules, while shaded spheres represent the presence of $Y_2$ molecules at the start of the reaction. What is the overall order of reaction?




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

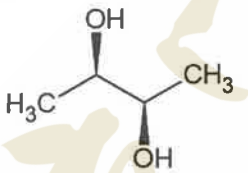
4. Michaelis and Menten assumed that the overall reaction for an enzyme-catalyzed reaction could be expressed as:

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} ES \xrightarrow{k_2} E + P$$

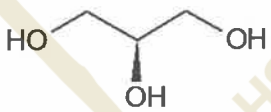
Based on above reaction, the rate of breakdown of the enzyme-substrate complex can be described by the expression:
(A) $k_1([E_t]-[ES])$
(B) $k_1([E_t]-[ES])[S]$
(C) $k_2[ES]$
(D) $k_{-1}[ES]+k_2[ES]$
(E) $k_{-1}[ES]$

5. Which one is not an input transducer?
(A) Mass analyzer
(B) Glass-calomel electrode
(C) Electron multiplier
(D) Photomultiplier tube
(E) Photodiode

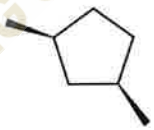
6. Please identify the meso compound(s) in the given chemical structures (I), (II) and (III).



I



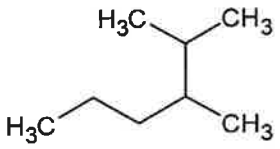
II


III

(A) I only
(B) II only
(C) III only
(D) I and III only
(E) I, II, and III

7. What is the volume of a cube ($V = L^3$) with the side length of $2.0 \pm 0.2$ cm?
(A) $8.0 \pm 0.008$ cm$^3$
(B) $8.0 \pm 0.2$ cm$^3$
(C) $8.0 \pm 0.6$ cm$^3$
(D) $8.0 \pm 1.4$ cm$^3$
(E) $8.0 \pm 2.4$ cm$^3$

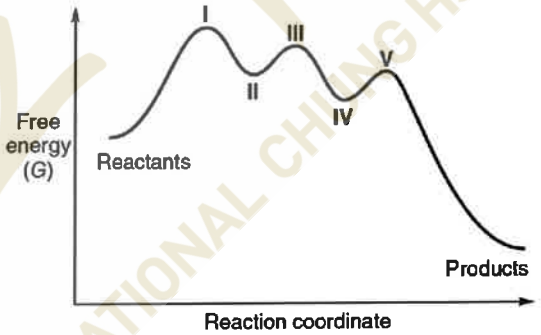
8. Please write the IUPAC name for the compound presented below.




(A) 2-propyl-3-methylbutane
(B) 4-isopropylpentane
(C) 2-isopropylpentane
(D) 5,6-dimethylhexane
(E) 2,3-dimethylhexane

9. Write the names for $P_4Se_3$ and $K_2[PtCl_4]$.
(A) Phosphorous selenide and potassium chloroplatinate
(B) Tetraphosphorous triselenide and dipotassium monotetrachloroplatinate
(C) Phosphorous selenide and potassium chloroplatinate(II)
(D) Tetraphosphorous triselenide and potassium tetrachloroplatinate(II)
(E) Phosphorous selenide and dipotassium tetrachloroplatinate

10. In the following energy diagram illustrating the progression of a reaction, please identify the location(s) indicating the presence of an intermediate?

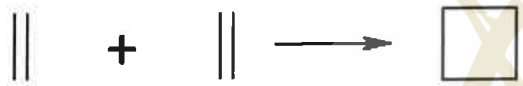



(A) Only I, III, and V
(B) Only II and IV
(C) Only I
(D) Only IV
(E) I, II, III, IV, and V


背面有題，請翻頁作答。

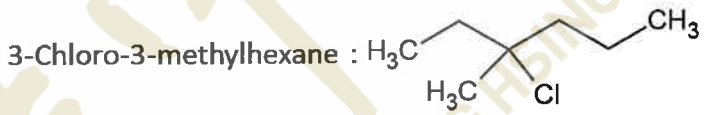
11. Which one would result in an endothermic $\Delta H_{solution}$?
(A) When $|\Delta H_{lattice}| < |\Delta H_{hydration}|$
(B) When $|\Delta H_{lattice}|$ is close to $|\Delta H_{hydration}|$
(C) When $|\Delta H_{lattice}| > |\Delta H_{hydration}|$
(D) When $|\Delta H_{solvent}| > |\Delta H_{solute}|$
(E) When $|\Delta H_{solvent}| < |\Delta H_{solute}|$

12. Which description best represents the change in entropy for the given reaction?



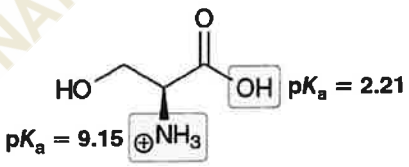
(A) $\Delta S = 0$
(B) $\Delta S = 1$
(C) $\Delta S > 0$
(D) $\Delta S < 0$
(E) None of the above

13. When 3-Chloro-3-methylhexane undergoes treatment with a strong base, how many distinct alkenes will be generated?




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

14. The following are the two pKa values for serine. What is the isoelectric point (pI) of serine?




(A) 9.15
(B) 6.94
(C) 5.68
(D) 2.21
(E) None of the above

15. Based on the provided bond energies, what is the $\Delta H°_{rxn}$ for the reaction below?

$$XeF_2 + 2\ F_2 \rightarrow XeF_6$$

| Bond | Bond energy (kJ $mol^{-1}$) |
|---|---|
| Xe-F | 147 |
| F-F | 159 |

(A) -564 kJ
(B) +564 kJ
(C) +270 kJ
(D) -270 kJ
(E) -612 kJ

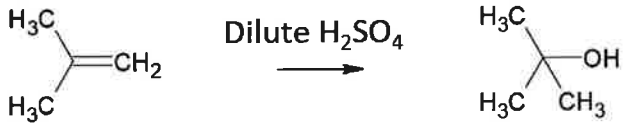
16. What is the solubility of $La(IO_3)_3$ ($K_{sp} = 1.0 \times 10^{-11}$) in a solution prepared by mixing 1.0 L of 0.0040 M $La(NO_3)_3$ with 1.0 L of 0.20 M $NaIO_3$?
(A) $1.0 \times 10^{-4}$ M
(B) $1.0 \times 10^{-6}$ M
(C) $1.0 \times 10^{-8}$ M
(D) $1.0 \times 10^{-9}$ M
(E) $1.0 \times 10^{-10}$ M

17. Which one has the less significant effect on the activity coefficient for a given species?
(A) Ionic strength of the solution
(B) Molar concentration of the species
(C) Charge on the species
(D) Temperature of the solution
(E) Effective diameter of the hydrated ion

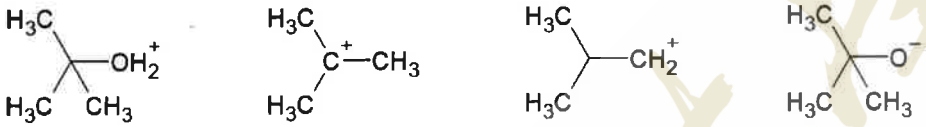


背面有題，請翻頁作答。

18. Consider the acid-catalyzed hydration reaction provided below:




Which cations and anions among the following are intermediates according to the approved mechanism for the above reaction?




I　　II　　III　　IV

(A) Only I and II
(B) Only I, II, and III
(C) Only III
(D) Only IV
(E) None of the above. The process is concerted

19. Which of the following outlines the characteristic pattern observed for an isopropyl group in a $^{1}H$ NMR spectrum?
(A)The spectrum contains a 1H septet and a 6H doublet
(B) The spectrum contains a 1H sextet and a 6H doublet
(C) The spectrum contains a 1H quartet and a 6H quartet
(D) The spectrum contains a 1H triplet and a 6H quartet
(E) The spectrum contains a 1H doublet and a 6H quartet

20. Which statement is correct?
(A) Comparison with standards is used to identify random error
(B) Calibration curve is used to compensate the matrix effect
(C) Standard addition method is used to reduce the random errors in measurements
(D) Standard addition method is used to compensate the matrix effect
(E) Internal standard is used to reduce the random error in measurements

21. Place the following in order of decreasing radius.

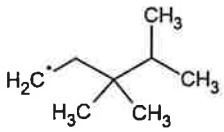
$Te^{2-}$　$F^-$　$O^{2-}$

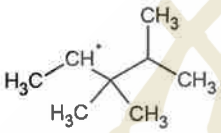
(A) $Te^{2-} > F^- > O^{2-}$
(B) $Te^{2-} > O^{2-} > F^-$
(C) $O^{2-} > F^- > Te^{2-}$
(D) $F^- > Te^{2-} > O^{2-}$
(E) $F^- > O^{2-} > Te^{2-}$

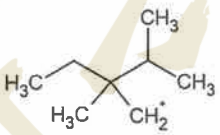
22. Commercial grade hydrofluoric acid (HF = 20.01 g $mol^{-1}$) solutions are typically 48.0% (w/w). What is the molality of the HF, if the solution has a density of 1.15 g $mL^{-1}$?

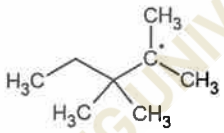
(A) 20.9 *m*
(B) 27.6 *m*
(C) 40.1 *m*
(D) 46.1 *m*
(E) 53.1 *m*

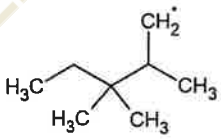
23. Among the following, which radical is the most stable?


I


II


III


IV


V

(A) I
(B) II
(C) III
(D) IV
(E) V

24. Place the following in order of decreasing magnitude of lattice energy.

NaF　MgO　CsI　AlN

(A) CsI > AlN > MgO > NaF
(B) AlN > MgO > NaF > CsI
(C) NaF > CsI > MgO > AlN
(D) AlN > MgO > CsI > NaF
(E) CsI > NaF > MgO > AlN

背面有題，請翻頁作答。

25. The method detection limit is
(A) The lowest concentration of the calibration curve
(B) The minimal detectable signal intensity of an analyte
(C) The lowest detectable concentration of an analyte
(D) The minimal measurable concentration of an analyte
(E) The minimum concentration of an analyte that can be reliably distinguished from the blank

26. What is the rate law for the given reaction and its mechanism?

$2\ HgCl_2 + C_2O_4^{2-} \rightarrow 2\ Cl^- + 2\ CO_2 + Hg_2Cl_2$ (overall reaction)

$HgCl_2 + C_2O_4^{2-} \rightleftharpoons HgCl_2C_2O_4^{2-}$ (fast)

$HgCl_2C_2O_4^{2-} + C_2O_4^{2-} \rightarrow Hg + 2\ C_2O_4Cl^{2-}$ (slow)

$Hg + HgCl_2 \rightarrow Hg_2Cl_2$ (fast)

$2\ C_2O_4Cl^{2-} \rightarrow C_2O_4^{2-} + 2Cl^- + 2\ CO_2$ (fast)

(A) Rate = $k[HgCl_2][C_2O_4^{2-}]$
(B) Rate = $k[HgCl_2]2[C_2O_4^{2-}]$
(C) Rate = $k[Hg_2Cl_2]$
(D) Rate = $k[HgCl_2][C_2O_4^{2-}]^2$
(E) Rate = $k[HgCl_2]^2[C_2O_4^{2-}]^2$

27. Which one has a different relationship between the signal and concentration?
(A) Scattering
(B) Fluorescence
(C) Phosphorescence
(D) Absorption
(E) Emission

28. A 50.0-mL aliquot of 1.0 M NaBrO (HBrO: $pK_a = 8.70$) is titrated with 1.0 M HCl. What is the pH after adding 25.0 mL of the acid?
(A) 11.30
(B) 9.30
(C) 8.70
(D) 5.30
(E) 3.30

29. Which option below outlines an effective method for relocating the position of a $\pi$ bond?
(A) Substitution, followed by addition
(B) Addition, followed by substitution
(C) Elimination, followed by addition
(D) Addition, followed by elimination
(E) None of the above

30. The nitrosonium ion, $NO^+$, forms numerous fascinating complexes with nickel, cobalt, and iron. Based on molecular orbital theory, which of the following statements accurately describes $NO^+$?
(A) The nitrosonium ion, $NO^+$, possesses a bond order of 2 and exhibits paramagnetism
(B) The nitrosonium ion, $NO^+$, possesses a bond order of 2 and exhibits diamagnetism
(C) The nitrosonium ion, $NO^+$, possesses a bond order of 3 and exhibits paramagnetism
(D) The nitrosonium ion, $NO^+$, possesses a bond order of 3 and exhibits diamagnetism
(E) None of these choices are correct

31. At pH 8.0, the predominant form of ethylenediaminetetraacetic acid (EDTA; $H_4Y$: $K_1 = 1.02 \times 10^{-2}$, $K_2 = 2.14 \times 10^{-3}$, $K_3 = 6.92 \times 10^{-7}$, $K_4 = 5.50 \times 10^{-11}$) is
(A) $H_3Y^-$
(B) $H_2Y^{2-}$
(C) $HY^{3-}$
(D) Equal amounts of $H_2Y^{2-}$ and $HY^{3-}$
(E) $Y4^-$

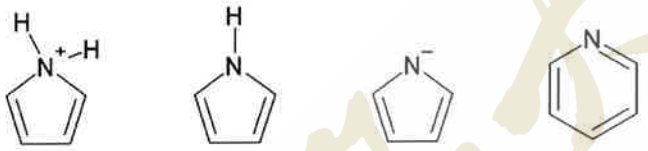
32. For a reaction producing both kinetic and thermodynamic products, which of the followings are linked to the kinetic product?
(I) It is formed faster.
(II) It is the more stable product.
(III) It involves the lower energy transition state.
(IV) It is favored with cold reaction conditions.

(A) Only I
(B) Only I, III and IV
(C) Only II
(D) Only II, III and IV
(E) Only III

背面有題，請翻頁作答。

33. How many lone pairs of electrons are in the Lewis structure of D-glucose ($C_6H_{12}O_6$ = 180.16 g $mol^{-1}$)?
(A) 4
(B) 6
(C) 8
(D) 9
(E) 12

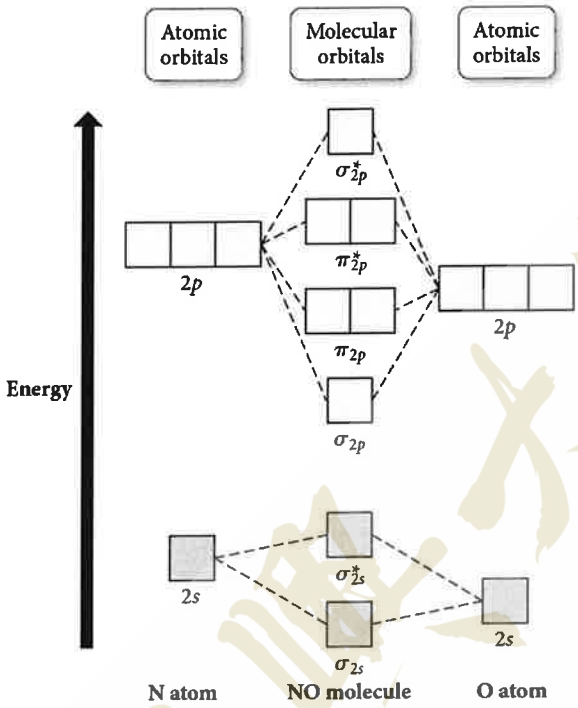
34. Which of the following structures represent aromatic compounds?



I　　II　　III　　IV

(A) Only I, II and III
(B) Only I, III and IV
(C) Only I, II, and IV
(D) Only II, III and IV
(E) I, II, III and IV

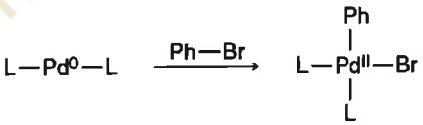
35. Based on the molecular orbital diagram shown below, which one is the most stable species?




(A) $NO^{2-}$
(B) $NO^{-}$
(C) NO
(D) $NO^{+}$
(E) $NO^{2+}$

36. Give the ground state electron configuration for $Se^{2-}$.
(A) $[Ar]4s^24p^6$
(B) $[Ar]4s^23d^{10}4p^2$
(C) $[Ar]4s^23d^84p^6$
(D) $[Ar]4s^23d^{10}4p^6$
(E) $[Ar]4s^23d^{10}4p^4$

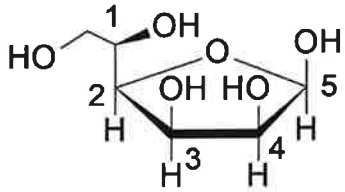
37. Displayed below is a step in the catalytic cycle of the Suzuki reaction, with 'L' representing a ligand. Which term from the provided options best describes this step?




(A) Oxidative addition
(B) Reductive elimination
(C) Transmetallation
(D) Nucleophilic substitution
(E) None of the above

背面有題，請翻頁作答。

38. Which carbon atom is referred to as the anomeric carbon?




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

39. Which complex ion, assuming M is the metal ion and X and Y are ligands in an octahedral geometry, can display geometric isomerism?
(A) $[MX_6]^{2+}$
(B) $[MX_5Y]^{2+}$
(C) $[MX_4Y_2]^{2+}$
(D) $[MX_3Y_3]^{2+}$
(E) None of the above

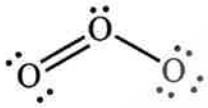
40. A solution is prepared by mixing 2.0 M $H_3A$ and 2.0 M $NaH_2A$ in the equal volume ($H_3A$: $pK_{a1}$ = 2.10, $pK_{a2}$ = 7.20, $pK_{a3}$ = 12.30). Which one is the closest to the pH value of this mixture?
(A) 2.10
(B) 2.45
(C) 4.65
(D) 7.20
(E) 9.75

41. Please select the accurate statements regarding entropy.
(I) After the mixing of two gases, ΔS is positive.
(II) Entropy is a thermodynamic property associated with the level of disorder.
(III) If the temperature of a gas decreases, ΔS is positive.
(IV) Molecules in the gaseous state exhibit higher entropy compared to those in the liquid state.

(A) Only I and III
(B) Only I, II, III
(C) Only I and II
(D) Only I, II, IV
(E) Only II and III

42. What is the pH of the 1.0 M $Na_2HAsO_4$ solution ($H_3AsO_4$: $pK_{a1} = 2.24$, $pK_{a2} = 6.96$, $pK_{a3} = 11.50$)?
(A) 2.24
(B) 4.60
(C) 6.96
(D) 9.23
(E) 11.50

43. In the illustrated resonance form of ozone below, what is the formal charge on the central oxygen atom?



(A) +2
(B) +1
(C) 0
(D) -1
(E) -2

44. Which statement accurately describes voltaic cells?
(I) Electrons flow from the anode to the cathode.
(II) Electrons flow form the more negatively charged electrode to the more positively charged electrode.
(III) Electrons flow from higher potential energy to low potential energy.

(A) Only I
(B) Only I and II
(C) Only I and III
(D) Only II and III
(E) I, II and III

45. Which solution has the highest pH?
(A) 0.1 M KCN, $K_a$ of HCN = $4.0 \times 10^{-10}$
(B) 0.1 M NaHS, $K_b$ of $HS^-$ = $1.8 \times 10^{-7}$
(C) 0.1 M NaOAc, $K_a$ of HOAc = $1.8 \times 10^{-5}$
(D) 0.1 M NaClO, $K_a$ of HClO = $3.2 \times 10^{-8}$
(E) 0.1 M $NH_4NO_3$, $K_b$ of $NH_3$ = $1.8 \times 10^{-5}$

背面有題，請翻頁作答。

46. In a decomposition reaction where the half-life is independent of the initial concentration of the reactant, what is the order of the reaction?
(A) Zero order
(B) First order
(C) Second order
(D) Third order
(E) The order cannot be determined without additional information

47. What is the molecular geometry of $SeCl_4$?
(A) Trigonal bipyramidal
(B) Tetrahedral
(C) Square pyramidal
(D) Seesaw
(E) Square planar.

48. What is the coordination number of an atom in the body-centered cubic unit cell, and how many atoms are present in the body-centered cubic unit cell?
(A) 8, 2
(B) 8, 4
(C) 12, 1
(D) 12, 2
(E) 12, 4

49. How many of the following species are paramagnetic?
$Cl^-$ Rb $Cu^+$ $Zn^{2+}$ $Zr^{2+}$ $Al^{3+}$
(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

50. A 100.0 mL sample of an aqueous solution at 27°C contains 15.2 mg of an unknown nonelectrolyte compound. If the solution has an osmotic pressure of 7.60 torr, which one is the unknown compound?
(A) $C_8H_{18}N_2O_2$
(B) $C_6H_{12}O_6$
(C) $C_{12}H_{22}O_{11}$
(D) $C_{20}H_{22}O_7$
(E) $C_{21}H_{20}O_{11}$