

上海科技大学 2018 年攻读硕士学位研究生

招生考试试题

科目代码：843

科目名称：有机化学

考生须知：

1. 本试卷满分为 150 分，全部考试时间总计 180 分钟。
 2. 所有答案必须写在答题纸上，写在试题纸上或草稿纸上无效。
 3. 每题的中文部分均已翻译为英文，考生可在中英文中任选一种语言作答。
-

一、单选题（1-30 题每小题 2 分，31-37 题每小题 3 分，共 81 分）

Multiple Choice. (2 points per problem for problems 1-30, 3 points per problem for problems 31-37, totally 81 points)

1. 下列化合物沸点最高的是？

Which of the following compounds has the highest boiling point?

- A. 正戊醇 (1-Pentanol) B. 正戊烷 (*n*-Pentane)
C. 异戊醇 (3-Methyl-1-butanol) D. 1-丁胺 (1-Butylamine)


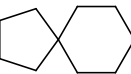

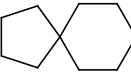
2. 下列碳正离子中，最不稳定的是：

Which of the following carbocation is the most UNSTABLE one?



3. 下列化合物的命名，正确的是：

Which of the following compounds has the correct name?

- A.  二环[2.2.1]庚烷 (Bicyclo[2.2.1]heptane)
B.  螺[5.4]癸烷 (Spiro[5.4]decane)
C.  二环[1.2.2]庚烷 (Bicyclo[1.2.2]heptane)
D.  螺[5.6]癸烷 (Spiro[5.6]decane)

4. 根据路易斯酸碱理论，下列选项哪一个是路易斯酸？

According to the Lewis acid-base theory, which of the following options is a Lewis acid?

A. 乙烯 (Ethylene) B. 乙基正离子 (Ethyl cation) C. 乙醚 (Ether) D. 乙醇 (Ethanol)

5. 组氨酸上的咪唑基进行甲基化可能产生两个异构体, 这是因为其咪唑基存在什么异构体?
Methylation of the imidazole ring in histidine may produce two isomers due to the presence of which structural isomers of the imidazole ring?

A. 互变异构体 (Tautomers) B. 顺反异构体 (Cis/trans isomers)
C. 差向异构体 (Epimers) D. 立体异构体 (Stereoisomers)

6. 下列糖类化合物中, 不具有还原性的糖有:
In the following carbohydrates, which one is a NON-REDUCING sugar?

A. 葡萄糖 (Glucose) B. 蔗糖 (Sucrose)
C. 麦芽糖 (Maltose) D. 甘露糖 (Mannose)

7. 核酸中碱基之间配对的主要化学基础是什么?
Which of the following forces is the major chemical basis for pairing between bases in nucleic acids?

A. 氢键 (Hydrogen bond) B. 范德华力 (Van der Waals interaction)
C. 盐桥 (Salt bridge) D. 疏水相互作用 (Hydrophobic interaction)

8. 某一氘代氯仿的样品中有少量常见溶剂未除尽, 在氢谱的高场区 ($\delta = 2.50$ ppm, 以四甲基硅烷为基准) 出现了一个单峰, 这个单峰可能对应的是:

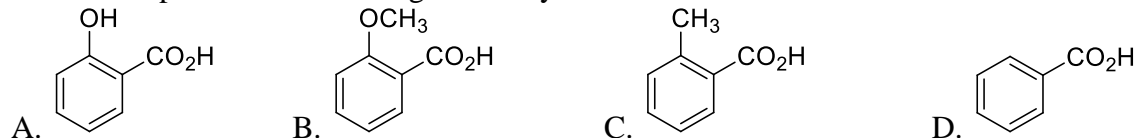
In a deuterated chloroform sample remains a tiny amount of unknown common solvent. The unknown solvent has a single peak in the high field of the ^1H NMR spectrum ($\delta = 2.50$ ppm, when tetramethylsilane was used as reference). Which compound may correspond to the single peak:

A. 丙酮 (Acetone) B. 二甲亚砜 (Dimethyl sulfoxide)
C. 乙腈 (Acetonitrile) D. 二氯甲烷 (Dichloromethane)

9. 在核磁研究中, 常见的自旋原子核是哪些?
What are the most commonly studied nuclei (with a nonzero nuclear spin) in NMR?

A. ^1H , ^{13}C , ^{15}N , ^{19}F B. ^1H , ^{12}C , ^{14}N , ^{18}F
C. ^1H , ^{13}C , ^{14}N , ^{18}F D. ^2H , ^{12}C , ^{15}N , ^{19}F

10. 下列化合物中, 水溶液酸性最强的是:
Which compound has the strongest acidity in solution?



11. 以下常用有机溶剂中, 甲基质子的酸性最强的是:
Which of the following common organic solvents has the most acidic methyl protons?

A. 硝基甲烷 (Nitromethane) B. 乙腈 (Acetonitrile)
C. 丙酮 (Acetone) D. 甲苯 (Toluene)

12. 下列化合物中碱性最弱的是:

Which compound is the weakest base?

- A. 吡啶 (Pyridine) B. 苯胺 (Aniline)
C. 吡咯 (Pyrrole) D. 三乙胺 (Triethylamine)

13. 下列物质中, 没有芳香性的是:

Which material is NON-AROMATIC?

- A. 单层石墨烯 (Graphene) B. 环戊二烯负离子 (Cyclopentadiene anion)
C. 环辛四烯 (Cyclooctatetraene) D. [18]轮烯 ([18]Rotene)

14. 下列化合物中, 没有手性的是:

Which compound is ACHIRAL?



15. 下列化合物中, 没有顺反异构体的是:

Which compound does NOT have cis/trans isomers?

- A. 偶氮苯 (Azobenzene) B. 乙烯基乙醚 (Vinyl ether)
C. 环辛烯 (Cyclooctenylene) D. 丁烯二酸 (Butenedioic acid)

16. 系列化合物末端氯代脂肪胺 $\text{Cl}(\text{CH}_2)_n\text{NH}_2$, 在碱性条件下发生 $\text{S}_{\text{N}}2$ 关环反应速率最快的是:

Among a series of aliphatic amines chlorinated at the end (common formula: $\text{Cl}(\text{CH}_2)_n\text{NH}_2$), which one has the fastest reaction rate of the $\text{S}_{\text{N}}2$ cyclization under alkaline condition?

- A. $n = 2$ B. $n = 3$ C. $n = 4$ D. $n = 5$

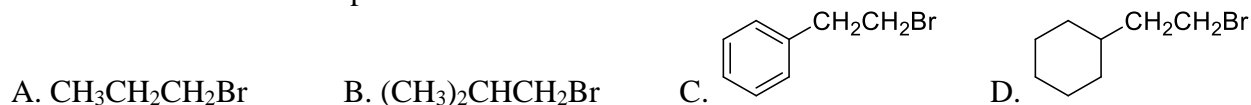
17. 在酸性条件下, 化合物 $(\text{CH}_3)_3\text{CCH}_2\text{OH}$ 脱水成烯烃的主要产物是:

When compound $(\text{CH}_3)_3\text{CCH}_2\text{OH}$ dehydrates into alkenes under acidic condition, what is the major product?

- A. $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}_3$ B. $(\text{CH}_3)_2\text{C}=\text{CHCH}_3$
C. $\text{CH}_2=\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_3$ D. $(\text{CH}_3)_2\text{CHCH}=\text{CH}_2$

18. 下列卤代烃中, 最容易发生消除反应的是:

Which haloalkane is most prone to have elimination reaction?



19. 下列卤代烃中, $\text{S}_{\text{N}}1$ 反应最容易进行的是:

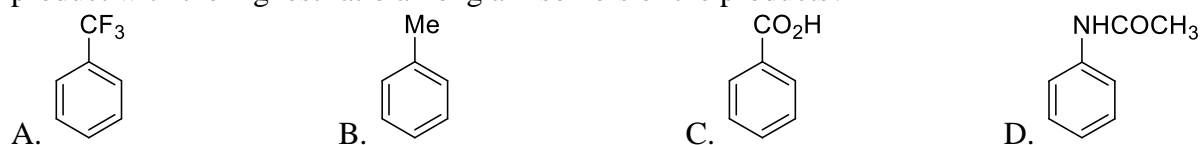
Which haloalkane is most prone to have $\text{S}_{\text{N}}1$ reaction?



20. 在 sp^3 杂化的饱和碳原子上进行亲核取代反应中, 下列基团中离去性能最好的是:
For nucleophilic substitution reaction on sp^3 saturated carbon atom, which of the following is the best leaving group?



21. 下列取代苯进行硝化反应时, 对位产物占所有异构体产物比率最高的是:
When having nitration reaction, which of the following substituted benzenes has the para position product with the highest ratio among all isomers of the products?



22. 格氏试剂苯基溴化镁与下列哪一个试剂反应可以获得三级醇:
To obtain a tertiary alcohol, Grignard reagent phenylmagnesium bromide needs react with which of the following reagents?

- A. 乙醛 (Acetaldehyde) B. 乙酸乙酯 (Ethyl acetate)
C. 环氧乙烷 (Ethylene oxide) D. 溴乙烷 (Bromoethane)

23. 下列有机物的俗名与其化学名不对应的是:
The common name of which compound is NOT a synonym of its chemical name?

- A. 甘油, 丙三醇 (Glycerol, Propanetriol)
B. 草酸, 羟基乙酸 (Oxalic acid, Hydroxyacetic acid)
C. 氯仿, 三氯甲烷 (Chloroform, Trichloromethane)
D. 糠醛, 2-呋喃甲醛 (Furfural, 2-Formylfuran)

24. 下列化合物中, 哪一个不是天然氨基酸?
Which compound is an UNNATURAL amino acid?



25. 目前实验室纯化化合物最常用的色谱层析中, 主要使用:
Currently, which material is the most commonly used in chromatography for compounds purifications in labs?

- A. 硅胶 (Silica gel) B. 海砂 (Sea sand)
C. 石膏 (Gypsum) D. 活性炭 (Activated charcoal)

26. 苯酚在一定条件下硝化得到邻硝基苯酚和对硝基苯酚的混合物, 可以通过下列哪种方法分离纯化:

Nitration of phenol results in a mixture of o-nitrophenol and p-nitrophenol. Which of the following methods can be used to separate the two products?

- A. 水蒸气蒸馏 (Steam distillation) B. 减压蒸馏 (Vacuum distillation)
C. 常压蒸馏 (Simple distillation) D. 无法分离 (Cannot be separated)

27. 在使用存放时间较长的四氢呋喃之前, 需要进行过氧化物检查, 可以使用:

Before using tetrahydrofuran that has been stored for a long time, a peroxides test is required. Which of the following test papers is appropriate for this purpose?

- A. 淀粉碘化钾试纸 (Potassium iodide-starch test paper)
B. pH 试纸 (pH test paper)
C. 硼砂试纸 (Borax test paper)
D. 氯化钴试纸 (Cobalt chloride test paper)

28. 实验室内钠块着火, 如何扑灭?

In laboratory, when sodium is on fire, how to extinguish it?

- A. CCl₄ 灭火器 (CCl₄ fire extinguisher) B. 水 (Water)
C. CO₂ 灭火器 (CO₂ fire extinguisher) D. 石棉布 (Asbestos cloth)

29. 有机化学实验中常用的回流冷凝管是:

Which organic refluxing tube is commonly used in organic chemistry lab:

- A. 空气冷凝管 (Air condenser) B. 球形冷凝管 (Allihn condenser)
C. 直形冷凝管 (Liebig condenser) D. 蛇形冷凝管 (Graham condenser/Dimroth condenser)

30. 鉴定含有甲基酮片段的有机物通常可以用:

Which reagent/test can be used to identify methyl ketone fragment in organic compounds?

- A. 碘仿实验 (Iodoform test) B. 卢卡斯试剂 (Lucas' reagent)
C. 斐林试剂 (Fehling's reagent) D. 土伦试剂 (Tollens' reagent)

31. 绿色植物进行光合作用所必需的催化剂叶绿素中含有的必不可少的金属离子是:

Chlorophyll is an essential catalyst for photosynthesis in green plants. Which metal ion is critical for the function of chlorophyll?

- A. Co B. Fe C. Mg D. Cu

32. 关于甾族化合物, 下列说法错误的是:

Which of the following statements is WRONG about steroids?

- A. 结构上的共同特点是含有一个四环体系

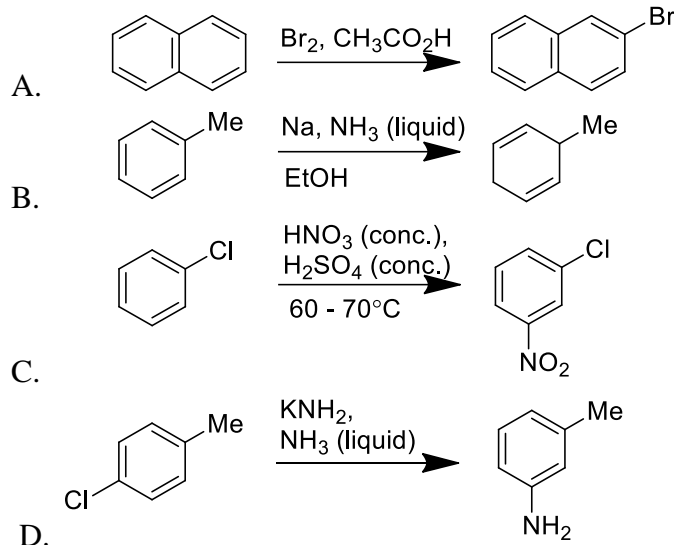
(The common structural feature shared among steroids is that they have four rings arranged in a specific configuration.)

- B. 其中的 A 环是五元环, 与 B 环并联
(The A ring is a five-membered ring, fused with the B ring)
- C. 广泛存在于动植物中, 许多此类化合物具有重要的生理功能
(Widely exist in animals and plants, and many have important physiological functions)
- D. 胆固醇是细胞膜的重要组成部分
(Cholesterol is an important component of cell membrane)
33. 关于苯酚, 下列说法错误的是:
Which statement is WRONG about phenol:
- A. 在碱性溶液中与四分子 Br₂ 反应生成沉淀
(Reacts with 4 eq. Br₂ in alkaline solution to generate precipitation)
- B. 与三氯化铁水溶液形成特征的红褐色络合物
(Forms characteristic reddish brown complex with ferric chloride solution)
- C. 可以溶于氢氧化钠水溶液
(Can be dissolved in sodium hydroxide solution)
- D. 其钠盐可以通过柯尔伯-施密特反应合成水杨酸
(Its sodium salt can be used to synthesize salicylic acid through Kolbe-Schmidt reaction)
34. 关于蛋白质测序, 下列说法错误的是:
Which statement is WRONG about protein sequencing:
- A. 桑格尔方法中采用 2,4-二硝基氟苯与 N-端氨基酸的氨基反应
(Sanger method uses 2,4-dinitrofluorobenzene to react with the amino group in the N-terminal amino acid)
- B. 艾德满方法中采用异硫氰酸苯酯与 N-端氨基酸的氨基反应
(Edman method uses phenyl isothiocyanate to react with the amino group in the N-terminal amino acid)
- C. 氨基酸序列的测定代表了其蛋白的二级结构的测定
(Determination of the amino acid sequence represents the determination of the protein secondary structure)
- D. 采用糜蛋白酶对检测蛋白进行水解时, 酪氨酸往往出现在裂解产物的 C-端
(When a protein is hydrolyzed by chymotrypsin, tyrosine tends to appear at the C-terminus of the cleavage products)
35. 关于手性化合物的合成或拆分, 下列说法错误的是:
Which statement is WRONG about synthesis and separation of chiral compounds?
- A. 外消旋体可以通过与光学纯的化合物反应生成非对映异构体, 通过结晶的方法进行分离纯化
(Racemates can be separated by reacting with an optically pure compound to form diastereomers followed by separation through crystallization)
- B. 外消旋体可以通过酶催化的化学反应进行拆分
(Racemates can be separated by enzymatic reactions)
- C. 外消旋体目前无法通过色谱柱进行拆分
(Currently, racemates cannot be separated by column chromatography)
- D. 没有手性诱导或辅助, 目前无法从非手性分子合成手性纯的化合物

(Without chiral induction or aid, currently chiral pure compounds cannot be synthesized from achiral molecules)

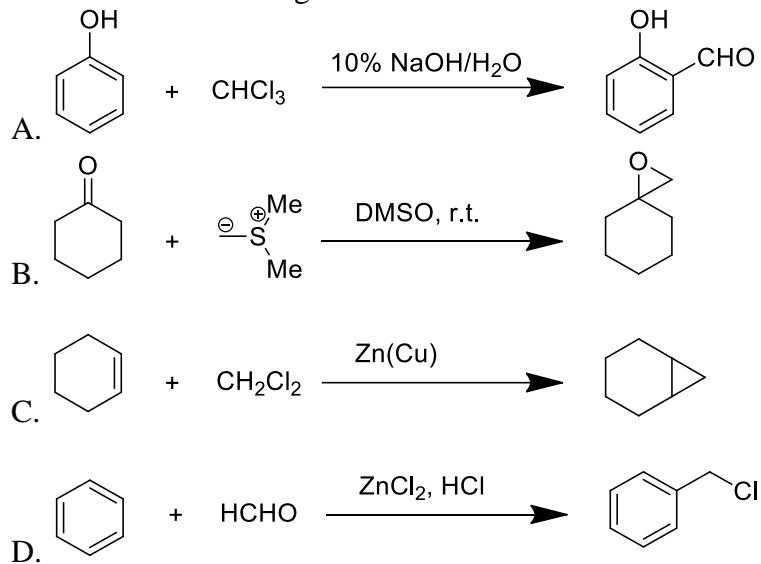
36. 下列反应主要产物正确的是:

Which of the following reactions has the correct major product?



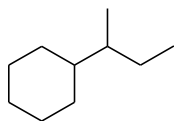
37. 下列化学反应涉及到卡宾中间体的是:

Which of the following reactions involves a carbene intermediate?



二、填空题 (38-44 题每小题 2 分, 45-49 题每小题 3 分, 共 29 分)

Blank filling (2 points per problem for problems 38-44, 3 points per problem for problems 45-49, totally 29 points)



38. 的化学名是_____。

Provide the IUPAC accepted name of the compound:_____.

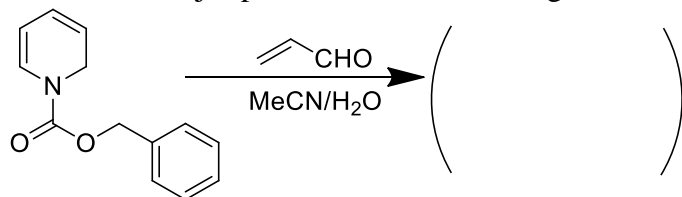
39. 根据分类, 列举已知的产品名称和其主要有有机物成分各一例 (任选两个作答即可)

For each of the following category, please list the name of a product and its major organic component (**you may choose any two categories**).

- | | | |
|----------------------------------|---|---|
| 医药 Medicine | (|) |
| 食品 Foods | (|) |
| 化妆品/香料 Cosmetics/Perfumes | (|) |
| 农药/化肥 Pesticides/Fertilizers | (|) |
| 染料 Dyes | (|) |
| 能源 Energy | (|) |
| 军用/民用物资 Military/Civil materials | (|) |
| 高分子材料 Polymer materials | (|) |

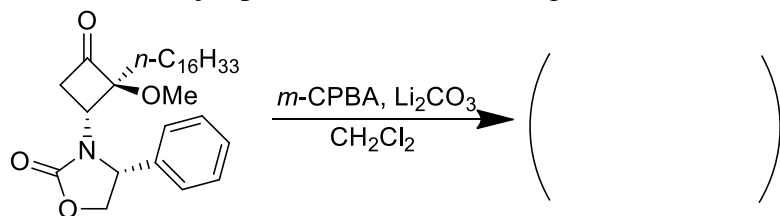
40. 写出主要产物:

Provide the major product for the following reaction.



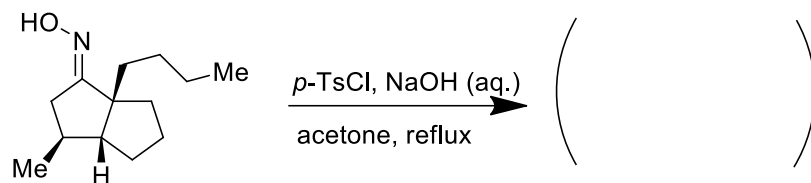
41. 写出主要产物:

Provide the major product for the following reaction.



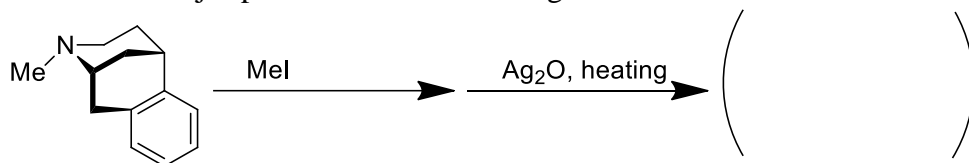
42. 写出主要产物:

Provide the major product for the following reaction.



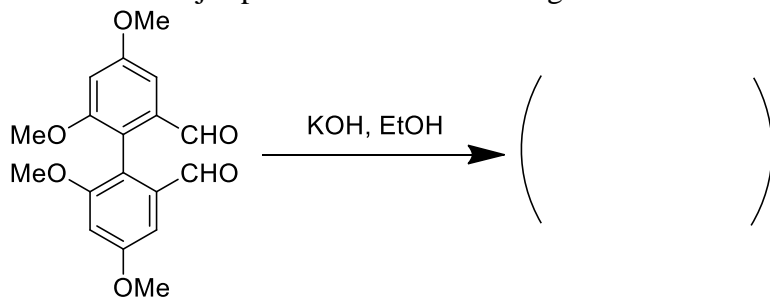
43. 写出主要产物:

Provide the major product for the following reaction.



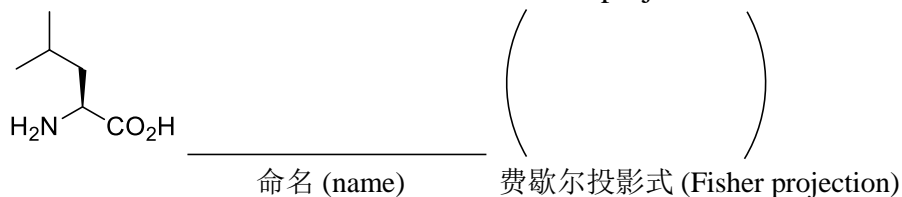
44. 写出主要产物:

Provide the major product for the following reaction.



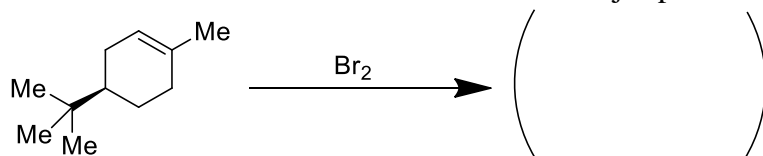
45. 用系统命名法命名下列化合物, 并写出其费歇尔投影式:

Provide the IUPAC name and draw the Fisher projection for the following compound.



46. 写出主要产物的稳定椅式构象:

Provide the stable chair conformation of the major product.



47. 写出每一步的主要产物:

Provide the major product for each step.



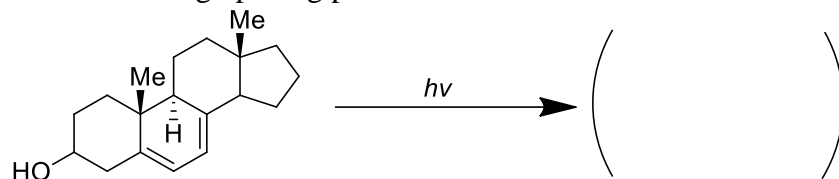
48. 写出每一步主要产物的稳定椅式构象:

Provide the stable chair conformation of the major product in each step.



49. 写出光照之后开环的产物:

Provide the ring opening product after illumination.

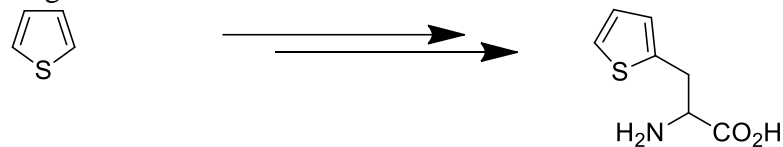


三、合成设计题 (50-53 题每小题 5 分, 共 20 分)

Synthetic design (5 points per problem, totally 20 points).

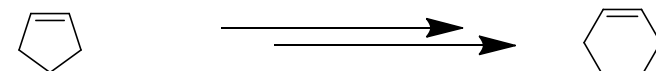
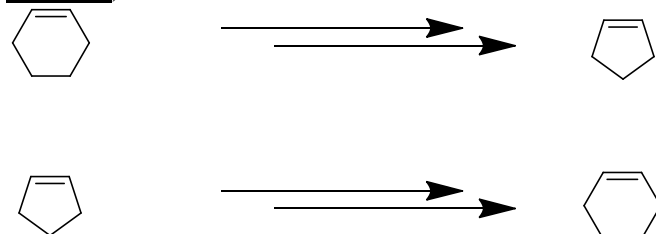
50. 从噻吩及其它常规试剂出发合成非天然氨基酸:

Provide a synthesis of the following unnatural amino acid from thiophene and other common reagents.



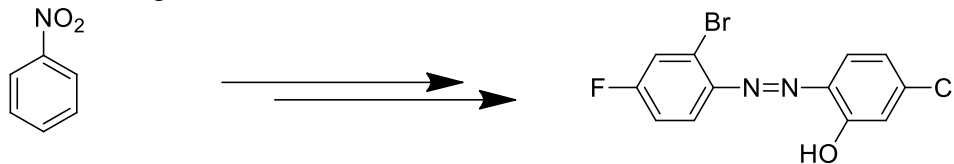
51. 从环己烯出发合成环戊烯, 或从环戊烯出发合成环己烯 (任选一题):

Provide a synthesis of cyclopentene from cyclohexene, or the opposite direction (**you may choose any one**).



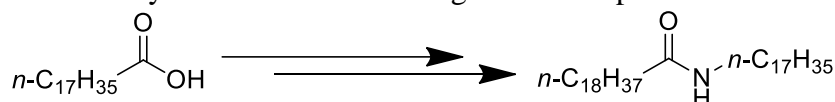
52. 从硝基苯及其它不含苯环的原料出发合成偶氮:

Provide a synthesis of the following azo compound from nitrobenzene and other reagents without benzene ring.



53. 从硬脂酸合成酰胺化合物:

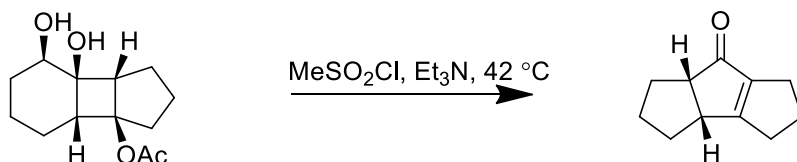
Provide a synthesis of the following amide compound from stearic acid.



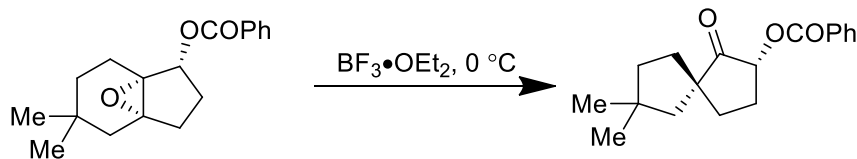
四、机理分析题。根据反应条件, 分析原料到产物的转化过程, 用箭头表明电子转移方向, 如涉及人名反应, 请注明。(54-55 题每小题 5 分, 共 10 分)

Mechanism analysis. Provide an arrow mechanism for the whole reaction process, including all intermediates. Please specify if any name reactions are involved. (5 points per problem, totally 10 points)

54.



55.



五、结构解析题 (56-57 题每小题 5 分, 共 10 分)

Structure determination (5 points per problem, totally 10 points)

56. 某二聚葡萄糖苷类化合物 A, 分子式为 $C_{19}H_{25}F_3O_{12}$ 。A 的核磁谱图表明只含有 β -糖苷键, 同时含有两组两重峰的芳香质子。A 经过全甲基化后用酸水解得到四-O-甲基化葡萄糖 B、三-O-甲基化葡萄糖 C 和苯酚类化合物 D。B 经硝酸氧化后得到三-O-甲基木糖二酸和二-O-甲基-L-酒石酸。A 用高碘酸氧化产生两分子甲酸。请推测化合物 A, B, C, D 的结构并写出推导过程 (不知道葡萄糖的手性结构, 但能给出正确连接方式最多仍可得 4 分)。

An unknown compound A is a disaccharide containing two glucose units. A has the formula $C_{19}H_{25}F_3O_{12}$. The NMR spectrum of A shows that it only has β -glycosidic bond. A also has aromatic protons which have two sets of doublet peaks in 1H NMR. Compounds B, C and D can be obtained from fully methylation and then hydrolysis of A. B is a tetra-*O*-methylglucose, C is a tri-*O*-methylglucose, and D is phenol compound. B can be oxidized to tri-*O*-methylxylaric acid and di-*O*-methyl-*L*-tartaric acid by nitric acid. One molecule of A can be oxidized to release two molecules of formic acid by periodic acid. Please provide the structures of compounds A, B, C and D as well as your reasons (If you can provide everything right except the chirality of glucose, you still get 4 points).

57. 某脂类分子 E, 分子式为 $C_{21}H_{40}O_4$ 。E 在碱性条件下水解可获得长碳链酸 F, F 被臭氧解后得到正壬醛和直链壬醛酸。E 可以被高碘酸降解失去一个碳原子。E 在光照条件下能发生异构化得到更稳定的异构体 G。请推测化合物 E, F, G 的结构并写出推导过程。

A lipid molecule E has the formula $C_{21}H_{40}O_4$. Long chain acid F can be obtained through hydrolysis of E under alkaline condition. Ozonation of F gives n-nonylaldehyde and linear azelaic semialdehyde. E can lose a carbon atom when degraded by periodic acid. Under illumination E can isomerize to G, which is more stable. Please provide the structures of compounds E, F and G as well as your reasons.