**Organic Chemistry Second Stage**

**Questions**

**Alkanes:**

**Q1:** What is organic chemistry?

**Q2:** What makes carbon so special?

**Q3:** Except for hydrogen, the common elements in organic compounds follow one rule in bonding:

**Q4:** Draw in all H’s and lone pairs in each compound:

C - C-Cl , C- C =O , C- C≡N

Q4: Fill in the lone pairs on each atom to give every main group element except hydrogen an octet.



Q5:



Q6:



**Q7: A *functional group*** is……

**Q8:** Identify all of the functional groups in Tamiflu.

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**Q9:** Why are Organic compounds have lower melting points than inorganic compounds?

**Q10:** The shape of the molecule determines the overall polarity. Explain how?

Q11: Determine whether each molecule is polar or nonpolar: (a) H2O; (b) CO2.

**Q9:** One rule governs solubility: **“Like dissolves like.”** Three facts can then be used to explain the solubility of organic compounds as……..

**Q10:** How many types of carbon in the following compounds and Name each one?



**Q11:**



**Q12:** Give the systematic name for each of the following compounds:

, , 

 

**Q13:**



**Q14:**A/ How many alkyl halides can be obtained from mono chlorination of the following alkanes? Calculate the percent yield of each product

1. 3,6-di(1-methyl-ethyl)-2,7-dimethyloctane, **b.** 1,3-dimethylcyclohexane
2. 2, 2, 5-trimethylhexane d. 3,6-diisopropyl-2,7-dimethyloctane .

**B/**Compound (A )has molecular formula (C8H16 )and undergoes monochlorination to produce three different constitutional isomers.

(a) Draw the structure of compound A.

(b) Draw all three monochlorination products.

(C) Calculate percentage yield of each isomer.

**Q15:** (A: C6H12) undergoes mono chlorination reaction to produce two different constitutional isomers (B &C). Draw the structure of (A, B & C) and calculate the percentage yield of both (B &C).

**Q16:** Compare the boiling points of different alkanes strait and brunched chain alkanes.

**Q17:** Write radical chain reaction mechanism for halogenation of methane.

**Alkenes**

**Q18:** Give the structure corresponding to each of the following names.

a. 2-methyl-2-octene b. 1,3-cyclohexadiene , c- 5-ethyl-2-methyl-2-heptene , d: 5-ethyl-2-methyl-1-nonene , e: 5-ethyl-2-methyl-1-nonene f: 4-ethyl-1-decyne.

And name the following:

  

, 

**Q19:** Compare between cis and trans 2-butene in terms of boiling point and polarity.

**Q20:** Does the addition of HCl to 2-methylpropene produce *tert*-butyl chloride or isobutyl chloride?

**Q21:** Explain the stability of 1,2 and 3 carbocations.

**Q22:** Why does the stability of a carbocation increase as the number of alkyl substituents bonded to the positively charged carbon increases?

**Q23:** Define Regioselectivity of Electrophilic Addition Reactions and deduce the major and minor products of the following reactions and other examples:

1. 2.methyl-2-butene + HCl→
2. 1-methylcyclohexene +HBr →

 **Q24:** What alkene should be used to synthesize 3-bromohexane?

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**Q25:**

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**Q26:** What do you mean by rearrangement reaction, write mechanism and determine the major and minor products of the following rearrangement reaction:

1. 3-methyl-1-butene + HBr →
2. 3,3-dimethyl-1-butene + HCl →

**Q27: Give different examples of Elimination reaction for the preparation of alkenes.**

**Alkynes**

**Q28:** Why is the transition state for the first step of an electrophilic addition reaction for an alkyne less stable than that for an alkene?

**Q29:** Explain the following order:

****

**Q30:** What alkyne should be used to the preparation of 3,3-dibromohexane?

**Q31:** Starting with ethyne, how could you make 1-bromopentane?



**Q32:** How could 2,6-dimethylheptane be prepared from an alkyne and an alkyl halide?

**Q33:** **Starting with (CH≡CH), how could you make the following compounds?**

1.

 



1. 

**Q34:** How could you prepare 3,3-dibromohexane from reagents that contain no more than two carbon atoms?

**Q35/** How can compare and explain the acidities of these compounds with the acidities of hydrogens attached to other second-row elements?



**Dienes**

**Q36:** Give the systematic name for each of the following compounds:

****

**Q37/**

 ** using E and Z system.**

**Q38/** Why is a conjugated diene such as 1,3-pentadiene more stable than an isolated diene?

**Q39/** Name the following dienes and rank them in order of increasing stability.



**Q40/** Give the major product of each of the following reactions, (equivalent amounts of reagents are used in each case):



1. 3,4-dimethyl-2,4-hexadiene + HBr →
2. Cyclopentadiene + HCl→
3. 2-methylcyclohexa-1,3-diene + HBr →

**Q41/** What products would be obtained from the reaction of 1,3,5-hexatriene with one equivalent

of HBr? Ignore stereoisomers.

**Q42/** Give the products of the following reactions, ignoring stereoisomers (equivalent amounts

of reagents are used in each case):



**Aromatic compounds**

**Q43/** What are the Rules for Drawing Resonance Contributors? And the electrons can be moved in one of the following ways:

**Q44/**Draw contributing resonance structures for each of the following species, and rank the structures in order of decreasing contribution to the hybrid:



**Q44/**Which of the following compounds have delocalized electrons?

,,CH3CH2NHCH2CH=CH2

**Q45/** Explain the following order:



Q46/ Explain Why is we obtain the following yields?



Q47/ complete the following reaction.

 ? + ? and Why?

Q48/ Why this priority toward addition of HBr?



**Q49/** Predict the sites on each of the following compounds where the reaction can occur(resonance):

**, **

**A50/** How can we tell whether a compound is aromatic? Use the Hückel rule to indicate the type of the following compounds, are aromatic, antiaromatic or non-aromatic?

****

 **[12] annulene ,  ,  , **

**Q51/** Indicate which of the following are aromatic and antiaromatic**?**



 

**Q52/** Which one is more stable? Cyclopetadienyl (cation or anion)

**Q53/** Compound A has molecular formula C8H8. When treated with excess Br2, compound A is converted into compound B, with molecular formula C8H8Br2. Identify the structures of compounds A and B.

 

**Q54/** Order and explain the compounds in each set with respect to……..

1. Acidity of Cyclopentadine and Cyclohepta-1,3,5-triene.
2. Water solubility of 3-bromocyclopropene and bromocyclopropane
3. Polarity of  and 
4. Stability of  and 

**Q55/** There are some limitation of Friedel–Crafts alkylation reaction how can you solve this problem?

**Q56/** What would be the major product of a Friedel–Crafts alkylation reaction using the following alkyl halides?

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**Q57/** Starting with a given starting material and using any other necessary reagents of your choice,

 design a synthesis of the following compounds.

1. 1-butyl-3-chlorobenzene from benzene
2. **from benzene**

**Q58/** Show two ways that the following compound could be synthesized:

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**Q59/** Draw a mechanism for the following transformation:

****

****

**Q60/** **Give the products of the following reactions:**

****

****

**Q61/** For each of the following substituents, indicate whether it donates electrons inductively, withdraws electrons inductively, donates electrons by resonance, or withdraws electrons by resonance (inductive effects should be compared with a hydrogen; remember that many substituents can be characterized in more than one way):



**Q62/** Draw the resonance contributors for nitrobenzene.

**Q63/** Are the following substituents ortho–para directors or meta directors?



**Q64/** Aniline and N-substituted anilines also do not undergo Friedel–Crafts reactions, while Phenol and anisole undergo Friedel–Crafts reactions—orienting ortho and para. Why?

**Q65/** Aniline also cannot be nitrated but , Tertiary aromatic amines, can be nitrated. Why ?

**Q66/**How could you prepare p- and m- chlorobenzoic acid from toluene?

**Q67/** Explain the reactivity of [] toward nitration reaction.

**Q68/** Match and explain the substituent's (R) with the corresponding activities in the following reaction.



|  |  |  |
| --- | --- | --- |
|  R |  | Activities  |
| 1: OCH3 | A: strongly activating and ortho, para director  |
| 2: COOH | B: moderately activating and ortho, para director  |
| 3: NH2 | C: strongly deactivating and meta director |
| 4: NO2 | D: moderately deactivating and meta director |
| **5: Br** | **E: weakly deactivating and, ortho, para director** |

**Q69a/ Complete the following reactions and predict the major product in each reaction.**

1. 
2. 1-chloro-3-(1-methylethyl)benzene + Br2 

Q69b/ Prepare the following compounds:

1. m-nitroacetophenone from benzene
2. 2-phenylethanol from benzene

**Alcohols and Phenols**

**Q70/** Write the structures of all the secondary and tertiary alcohols with molecular formula and give each a systematic name.

**Q71/** Identify which of the following compounds is expected to be more acidic:

 

**Q72/**For each of the following pairs, identify the one that is more acidic, and explain your choice:

;; 

 

**Q73/**Identify reagents that can be used to achieve each of the following transformations:

(a) To convert 1-hexene into a primary alcohol

(b) To convert 3,3-dimethyl-1-hexene into a secondary alcohol

(c) To convert 2-methyl-1-hexene into a tertiary alcohol

**Q74/**Show how you would use a Grignard reaction to prepare the following compounds:

 ;; ;; 

Q75/ calculate the oxidation state of carbon and the number of electrons lost in each step:

 

**Q76/** Compare and explain the acidity between phenol, cyclohexanol and benzoic acid

**Q77/**Providean IUPAC name for each of the following compounds.

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**Q78/** There are six ethers with molecular formula C5H12O that are constitutional isomers.

(a) Draw all six constitutional isomers.

(b) Provide a systematic name for each of the six compounds.

(c) Provide a common name for each of the six compounds.

**Q79/** Show the reagents you would use to prepare the ethoxy benzene via a Williamson ether synthesis.

**Aldehydes and Ketones**

**Q80**/What is the typical reaction of aldehydes and ketones and Why aldehydes are reactive than ketones?

**Q81/** Draw and five ketones of the general formula C6H8O

 Give the structure formula of:

 4-methyl-3-pentene -2-one, 1,3-diphenyl-2-propene-1-one.

**Q82/**which ketone is more reactive?

 a. 2-heptanone or 4-heptanone

 b. *p*-nitroacetophenone or *p*-methoxyacetophenone

**Q83/** What do you mean by addition-elimination reaction give and example?

**Q84/** Write a suitable mechanism for one of the following:



**Q85:** How can the following compounds be prepared, starting with a carbonyl compound with one fewer carbon

 atoms than the desired product?

 HOCH2CH2NH2, CH3CH(OH)COOH

**Q86/** List the compounds in each of the following groups in order of decreasing acidity:



**Q87/** Compare between aldol addition and mixed aldol addition give an example:

**Q88/**Under certain conditions, a mixed aldol addition can lead primarily to one product. How? Give an example

**Carboxylic acids and their derivatives**

**Q89/** Give the IUPAC name for the following carboxylic acids. (*a*) CH3(CH2)4COOH (caproic acid); (*b*) (CH3)3CCOOH (pivalic acid); (*c*) (CH3)2CHCH2CH2COOH (γ-methylvaleric acid);

(*d*) C6H5CH2CH2COOH (β-phenylpropionic acid);

(*e*) (CH3)2C(OH)COOH (α-hydroxyisobutyric acid);

(*f* ) HOOC(CH2)2COOH (succinic acid; no derived name for this one).

**Q90/** Name the following aromatic carboxylic acids.



**Q91/**Draw and name compounds that meet the following descriptions

1. Two tertiary amides having the molecular formula C5H11NO.
2. Tow esters having the molecular formula C5H8O2
3. Two anhydrides having the molecular formula C6H10O3

 ( Notes : all compounds have no C=C bonds.)

**Q 92/** Different alkylbenzenes are oxidizes to benzoic acid ?

**Q93/**Compare and explain the boiling points?



**Q94/** why is one mole of acyl halide react with 2 moles of ammonia or amines ?

**Q95/** Only one amide is obtained from the reaction of acetyl chloride with a mixture of ethylamine

* and pyridine. Why is only one amide obtained? Or why 1:1 mole.

**Q96/** Although excess amine is necessary in the reaction of an acyl chloride with an amine, explain

 why it is not necessary to use excess alcohol in the reaction of an acyl chloride with an alcohol.

Why?

**Q97/ Give structural formulas and names for compounds A through K .**

1. A (C10H14) + KMnO4 → B(C8H6O4) . [A = 1,2-Disubstituted benzene ].
2. B + ∆ → C(C8H4O3) + H2O
3. **C** + NH3 → D(C8H7NO3)
4. D + ∆ → E(C8H5NO2) + H2O
5. E + C2H5Br + OH- → F (C10H9NO2)
6. F + HCl + H2O + ∆ → B + G (C2H8NCl)
7. **C** + Benzene + AlCl3 → H (C14H10O3 )
8. H + Zn(Hg)HCl → I (C14H12O2 )
9. I + thionyl chloride → J (C14H11OCl ) 10. J + AlCl3 → K (C14H10O ).

**Q98/** Answer by ( < ) or ( > ) and give your reasoning.

1. Propionic acid is ( ) boiling point than propanamide.
2. Hydrofluoric acid is ( ) acidic than ethanoic acid .
3. CH2=CHCOOH is ( ) acidic than CH≡C-COOH .
4. Benzoic acid is ( ) acidic than cyclohexane carboxylic acid.
5. Ethanoic acid is ( ) acidic than Ethanol while ( ) acidic than Ethaneperoxoic acid.
6. The first proton (H) for propanedioic acid is ( ) acidic than the second.
7. Amides are ( ) reactive than amines toward nucleophilic substitution.
8. Phenyl acetate is ( ) reactive than ethyl acetate toward nucleophilic substitution .

 10- ethannitrile is ( ) hydrolyzed than ethanamide .

**Q99/**



Hofmann rearrangement of amide to primary amines (lower one carbon number)



**Write a Mechanism ?**

**Q100/** Order and explain the compounds in each set with respect to……..

1: Boiling points of propanoic acid, propanol and propanamide.

3: Relative reactivity of acetic anhydride, acetic acid and acetamide toward nucleophilic substitution.

**Final examination Questions**

**Q101/ Explain the following**

1. Reaction of 3-methyl-1-butene with HBr gives 2-bromo-2-methylbutane as a major product?
2. 1,3-butadiene is more stable than cyclobutadiene
3. Aniline is more reactive than nitrobenzene toward electrophilic substitution reactions.
4. 2-bromopropanoic acid is more acidic than 3-bromopropanoic acid
5. When excess Br2 is added to a *basic* solution of an aldehyde the halogen replaces *all* the α- hydrogens.
6. Aniline and N-substituted anilines do not undergo Friedel–Crafts reactions?
7. Blood alcohol level can be determined in individuals suspected of driving under the influence.
8. Relative reactivity of alkyl halides toward SN1 reaction is 1< 2 <3 .
9. Aryl halides are unreactive toward nucleophilic substitution reactions.
10. Acetic anhydride is more reactive than acetamide toward nucleophilic substitution

**Q102/ Indicate whether the statement is true or false. If false, change the underlined word or**

 **phrase to make the statement true.**

**1**- propanoic acid is higher boiling point than propanamide

2- Phenol is more stable than cyclohexa-2,4-dienone

3- The compound (2, 3-dimethylpentane) contain all types of carbon (1o, 2o, 3o and 4o)

4- Tertiary carbocations are more stable than secondary and primary carbocations because of hybridization.

5- The hydration ( addition of water) of ethyne gives ethenol as a major product

6- Ethyne is a stronger acid than ethene, and ethene is a stronger acid than ethane because of hyperconjugation.

7- Phenol is more stable than cyclohexa-2,4-dienone

8- (2-bromoethyl)benzene is more reactive than (3-bromopropyl)benzene toward SN1 reaction .

9- A reaction in which two or more constitutional isomers could be obtained as products, but one of them predominates, is called a regioselective reaction.

10- Ethyne is a stronger acid than ethene, and ethene is a stronger acid than ethane because of hyperconjugation.

11- Aldol condensation between benzaldehyde and propanone gives two aldol products

**Q103/ Starting with a given starting material and using any other necessary reagents of your choice, design a**

 **Synthesis of the following compounds.**

1: 3-bromohexane from a suitable alkene

2: 2-methylpent-2-enal from a suitable aldehyde

3: CH3CH2NH2 from CH3CH2Br using Gabriel synthesis

4: m-nitroacetophenone from benzene

5: 2-hyroxybenzaldehyde from phenol

6- 1-bromo-pentane from ethyne

7: Pentanoic acid from butanol

8: m-nitroacetophenone from benzene

9: 2-phenylethanol from benzene

10: ( propyl phenyl ether) according to Williamson synthesis of ethers.

**Q104/ Order and explain the compounds in each set with respect to……..**

1: Boiling points of propanoic acid, propanol and propanamide.

2: Relative reactivity of methoxy benzene , bromobenzene and (PhNH3+) toward electrophilic substitution.

3: Relative reactivity of acetic anhydride, acetic acid and acetamide toward nucleophilic substitution.

4: Acidity of Cyclopentadine and Cyclohepta-1,3,5-triene.

1. Basicity of CH3CH=NH or CH3C ≡N
2. Water solubility of Acidity of Cyclopentadine and Cyclohepta-1,3,5-triene
3. Stability of 
4. Polarity of  and 
5. Similarity of  with  and  with 