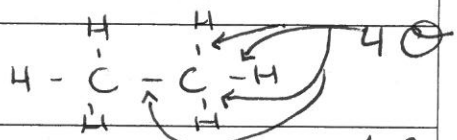
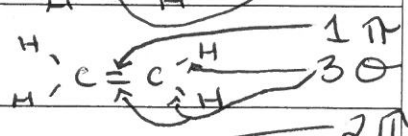
Name_____Period___

Extra Practice: Chapter 4 Test

Bond Chart (2 Questions)

Features	Alkene	Alkyne
Rotation	Restricted	none
Bond Length	Medium	Short
Bond Angle	120°	180°
Geometry	Trigonal Planar	Linear

Orbitals and Bonds (2 Questions)

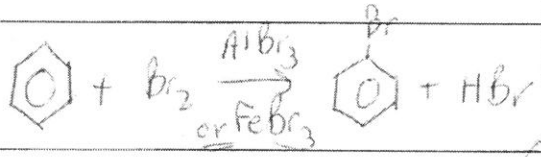
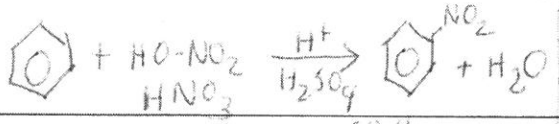
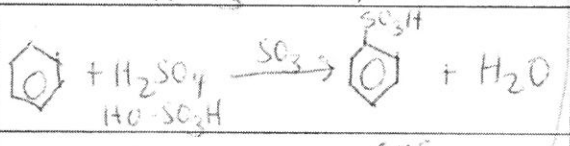
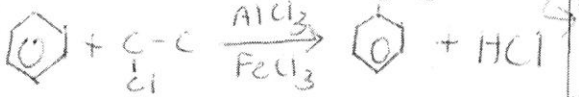
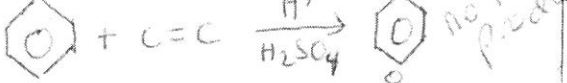
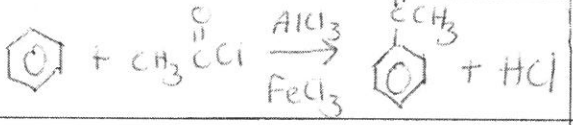
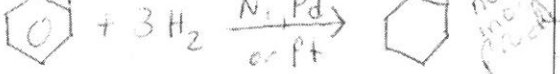
Organic Molecule	Type of Bond Hybridization	Drawing of Bond Types Present
Alkane	sp^3	
Alkene	sp^2	
Alkyne	sp	

Type of Bond	What types of Organic Molecules contain these bonds?	Strength of bond
Sigma	single & multiple bonds (-anes, enes, ynes)	strong
Pi	multiple bonds -enes + -ynes	weak

Name_____Period___

Review #2: Chap 4 Aromatic Reactions

Complete the following table. Write the equations **using benzene as the starting organic molecule**.

	Type Reaction	Equation	Explain or diagram how the catalyst interacts with the reagent to create the electrophile
1.	Bromination (Would be similar for any halogen)		Br-Br + vacant side $AlBr_3$ → Br-Br-$AlCl_3$ δ+ ← electrophile; similar to #4 below
2.	Nitration		Catalyst H^+ combines w/ the OH of HO-NO_2 to form H_2O leaving $+NO_2$ as electrophile
3.	Sulfonation		XXX SKIP THIS ONE XXX
4.	Alkylation (Add an ethyl group)		Catalysts $AlCl_3$ or $FeCl_3$ have an empty spot in valence shell that pulls 1 Cl off Cl_2 leaving Cl^+ as electrophile
5.	Alkylation again! (2nd way to add ethyl)		H^+ adds to 1 of the carbons of double bond, following Markovnikov's rule, resulting in + charge on other carbon
6.	Acylation (create acetophenone as a product)		Empty side on $AlCl_3$ pulls Cl off reagent, leaving + charge on the carbon double bonded to the C
7.	Hydrogenation		Not needed

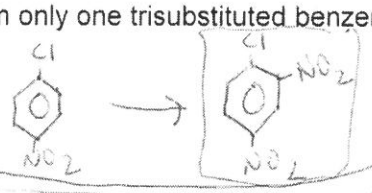
Complete the following table on Ortho,Para vs. Meta Directors, Activating vs. Deactivating

	Substituent	Is it an o,p-director or m-director?	Explain why it is that type of director. (Example: If you drew out the intermediate resonance structures, what would you circle as evidence?)	Is it Activating or Deactivating?
8.	-CN	m	• N more electronegative than C • δ+ on C too close to + in resonance	de
9.	$-C-\overset{O}{\overset{\|\|}{C}}-OH$	o, p	• 3° carbocation in o, p resonance	act
10.	$-CO_2H$	m	• δ+ on C because O is more electroneg • + charge too close in o, p	de
11.	$-NH\overset{O}{\overset{\|\|}{C}}CH_3$	o, p	4th resonance structure in o, p b/c of unshared e⁻ pair on N	act

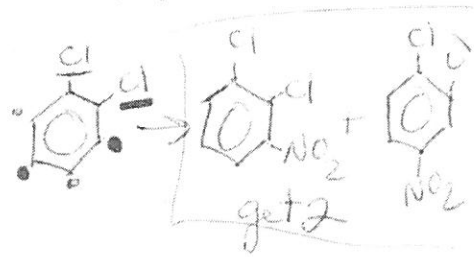
12.	$-NO_2$	m	• δ+ on N b/c O more electneg • + charge too close in o,p resonance	de
13.	$-SO_3H$	m	• δ+ on S b/c O more electneg • + charge too close in o,p resonance	de
14.	-OH	o,p	• 4th resonance in o,p resonance due to unshared e- pair on Oxygen	act
15.	$-OCH_3$	o,p	→ Same	act
16.	-F	o,p	• 4th resonance in o,p due to unshared e- pair on F	de

17. Which of the following can form only one trisubstituted benzene upon nitration? (May be more than one answer.)

a. p-chloronitrobenzene

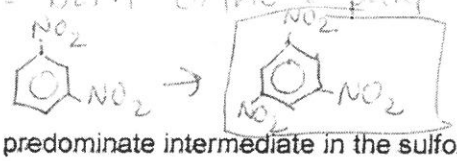


b. o-dichlorobenzene

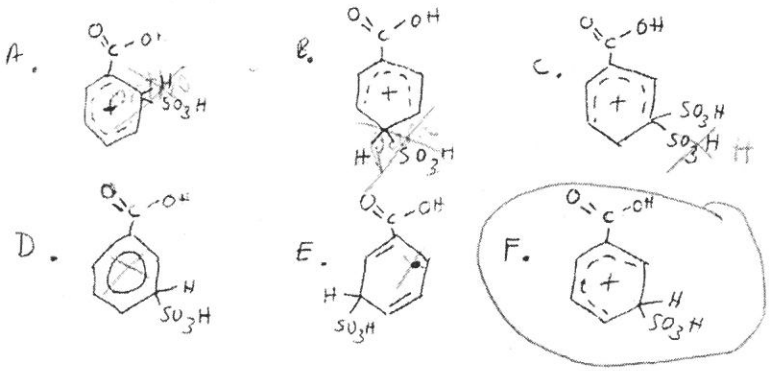


c. Aniline → get 2 ∴ both of the o,p pairs

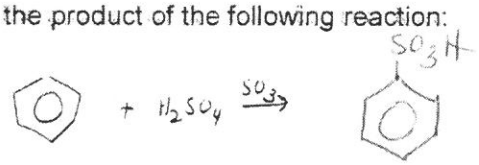
d. m-dinitrobenzene



18. Which of the following is the predominate intermediate in the sulfonation of benzoic acid?

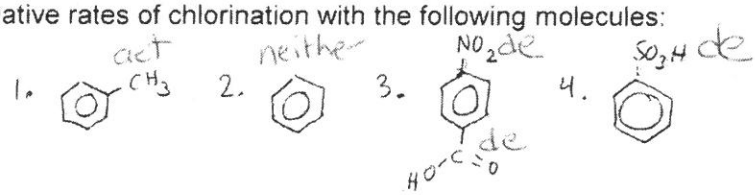


19. Name the product of the following reaction:



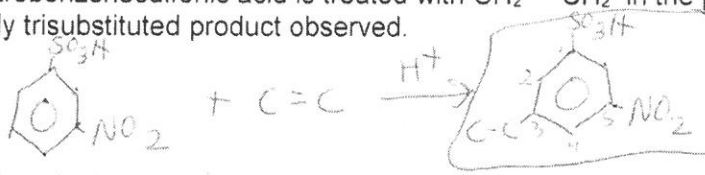
benzene sulfonic acid

20. Rank the relative rates of chlorination with the following molecules:



A. 4 > 2 > 1 > 3 B. 3 > 2 > 1 > 4 C. 2 > 1 > 4 > 3 D. 1 > 2 > 3 > 4 E. 1 > 2 > 4 > 3

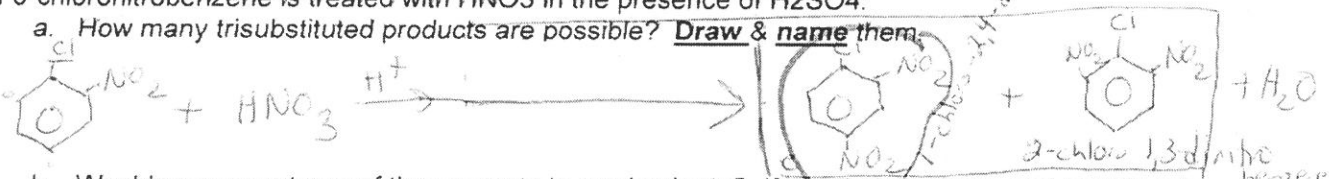
21. If m-nitrobenzenesulfonic acid is treated with $CH_2 = CH_2$ in the presence of H2SO4, **draw** & **name** the only trisubstituted product observed.



3-ethyl-5-nitrobenzenesulfonic acid

22. If o-chloronitrobenzene is treated with HNO3 in the presence of H2SO4:

a. *How many trisubstituted products are possible?* **Draw** & **name** *them.*



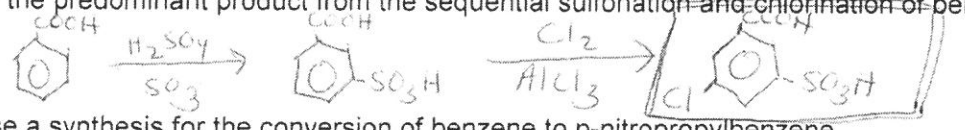
1-chloro-2,4-dinitro

2-chloro 1,3-dinitrobenzene

b. Would you expect one of the products to predominate? If so, circle it above and explain why it would predominate.

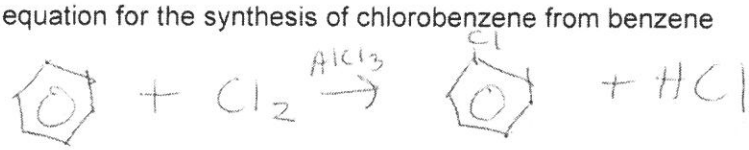
predom b/c substituents further apart

23. Draw the predominant product from the sequential sulfonation and chlorination of benzoic acid.

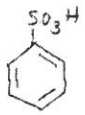


24. Devise a synthesis for the conversion of benzene to p-nitropropylbenzene.

25. Write an equation for the synthesis of chlorobenzene from benzene



26. Draw the resonance structures for the carbocations formed during the nitration of the following molecule.

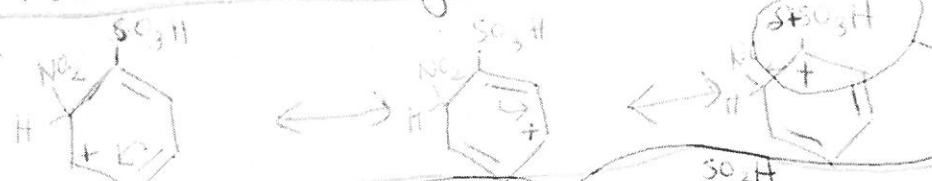


A. Include resonance drawings for ortho, para, and meta substitutions. LABEL as o, p, or m. Note: the resonance structures for each, should show proper placement of the positive charge and bonds based on the molecule drawn below.

B. Explain with words why the molecule was o,p-directing or m-directing. Then designate (circle, etc.) the portions of the drawings that support your explanation.

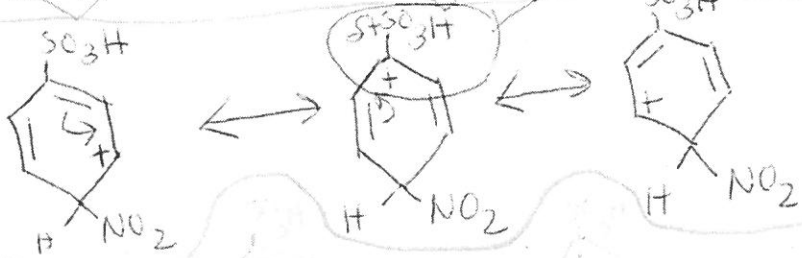
☆ Note - Instructions forgot to specify whether to add to right or left. The 1st set adds to left. Next page has added to right.

ortho



O is more electroneg than S, creating δ+ on S.

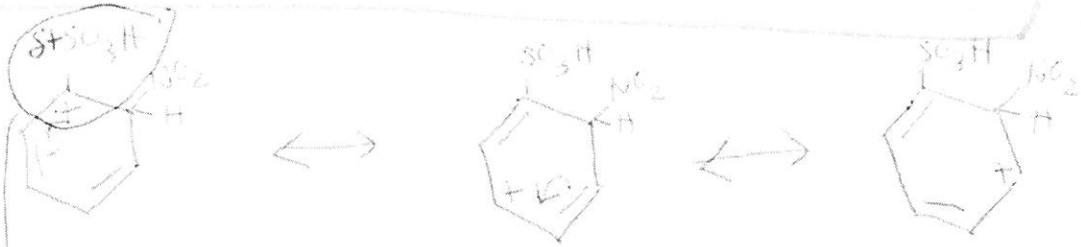
para

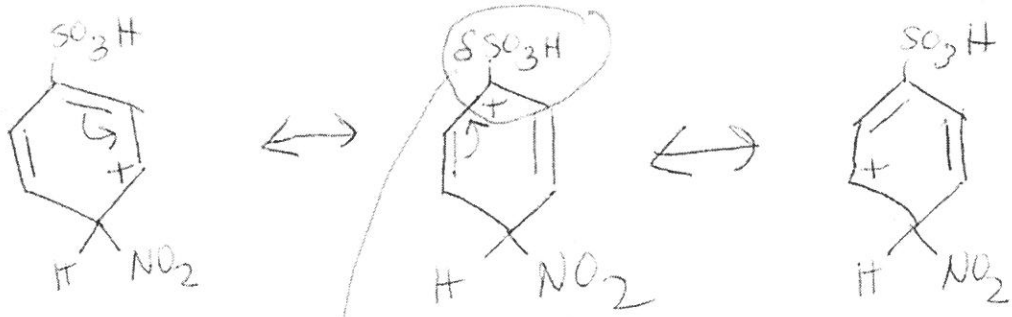


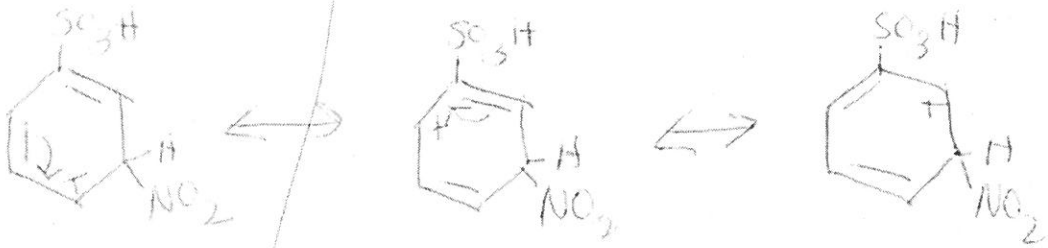
In o,p the 2 + charges are too close together. Therefore, meta is preferred

meta

#28 If added to right side of 

ortho 

para 

meta 

O is more electronegative than S, causing δ+ on S.
In o,p resonance, the two positive charges are too close together.
Therefore, meta is preferred