Name: Answer Key Section_____

CHEM 226: Elementary Organic Chemistry
Exam 2 spring 2013 **March 20, 2013**

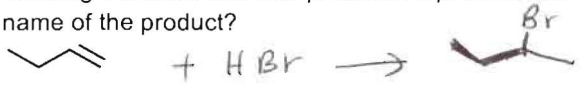
1. How many stereogenic carbons are produced in the product of the following sequence of reactions?

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

(B)

2-Chiral centers generated

2. Treating 1-butene with HBr produces a product with one stereogenic carbon. What is the name of the product?

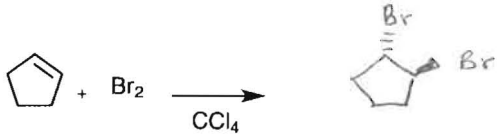


A) 2-bromo-1-butene
B) 1-bromobutane
C) (*R*)-2-bromobutane
D) (*S*)-2-bromobutane
E) Both C and D in equal amounts

(E)

Since rxn proceeds via carbocation intermediate, the reaction produces a racemic mixture (R and S 2-bromobutane)

3. What is the name of the product formed from the following reaction?

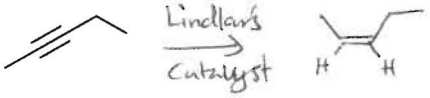


trans-1,2-dibromocyclopentane

A) bromocyclopentane
B) 1,1-dibromocyclopentane
C) *cis*-1,2-dibromocyclopentane
D) *trans*-1,2-dibromocyclopentane
E) 1,1-dibromocyclopentene

(D)

4. Addition of H_2 to 2-pentyne in the presence of the Lindlar's catalyst will produce:



(C)

cis-alkene product

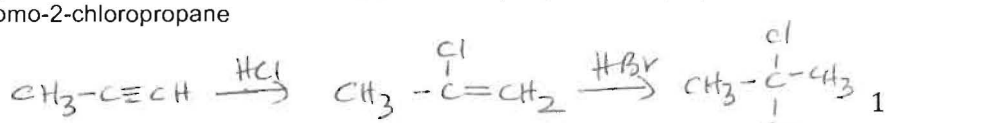
A) pentane
B) 1-pentene
C) *cis*-2-pentene
D) *trans*-2-pentene

5. What is the final product of adding 1 mole of each reactant in the following sequence?

A) propyl chloride
B) propyl bromide
C) 1-bromo-2-chloropropane

(D)

D) 2-bromo-2-chloropropane
E) 2,2-dibromopropane



2-bromo-2-chloropropane

6. What type of carbocation will form from the addition of a H^+ to 2-methylpropene?

tertiary carbocation

A) H_3C^+
B) 1°
C) 2°
D) 3°
E) Allyl

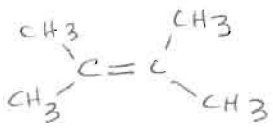
D

7. Upon ozonolysis which alkene will give only acetone, $(CH_3)_2C=O$?

A) 2,3-dimethyl-2-butene
B) 2,2-dimethyl-2-butene
C) 3-hexene
D) 2-methyl-2-pentene
E) 2-methyl-3-hexene

A

$(CH_3)_2C=O$ must be obtained from



2,3-dimethyl-2-butene

8. What is the percent s character in an sp^2 hybrid orbital?

A) 25%
B) 33%
C) 50%
D) 67%
E) 75%

s character in sp^2 = $\frac{1}{3} \times 100 = 33\%$

B

9. The triple bond in ethyne is made up of

A) two pi bonds and a sigma bond, each formed by a lateral overlap of two p orbitals.
B) a sigma bond formed by overlap of two s orbitals and two pi bonds, each formed by lateral overlap of two p orbitals.
C) a sigma bond formed by end-on overlap of two sp^2 orbitals and a pi bond formed by lateral overlap of two p orbitals.
D) two pi bonds, each formed by lateral overlap of two p orbitals, and a sigma bond formed by end-on overlap of two sp orbitals.
E) two pi bonds, each formed by end-on overlap of two p orbitals, and a sigma bond formed by lateral overlap of two sp orbitals.

D

10. Bending vibrations in the infared region occur at:

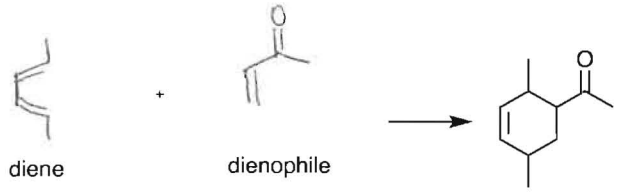
A) 3000 cm^{-1}
B) 2200 cm^{-1}
C) 1700 cm^{-1}
D) below 1400 cm^{-1}
E) over 3000 cm^{-1}

often shows in the fingerprint region below $1400 cm^{-1}$

D

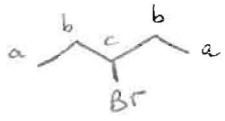
Short Answer Questions

11. The Diels-Alder reaction is very important in the synthesis of six-membered rings. Draw the reagents that can be used to synthesize the product shown by this method?



diene dienophile

12. How many peaks would you expect in the proton decoupled **^{13}C NMR spectrum** of 3-bromopentane?



3-peaks in ^{13}C NMR

13. A monochloroalkane shows two parent ion peaks *m/z* at 92 and 94. What is the molecular formula? (^{35}Cl and ^{37}Cl are the most common isotopes of chlorine)

$C_nH_{2n+1}Cl = 92$.

$12n + 2n + 1 + 35 = 92$.

$14n + 36 = 92$

$14n = 56$

$\Rightarrow n = \frac{56}{14} = 4$

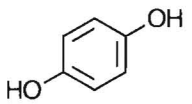
Therefore Molecular formula is C_4H_9Cl

14. A student lost the labels of two compounds and was required to run experiments to distinguish and identify them. She took an IR spectrum of both compounds A and B and both showed a broad band in the 3200 to 3500 cm^{-1} region of their IR spectrum? She then took both ^{1}H NMR and ^{13}C NMR spectra, and compound A had four peaks, while compound B had two peaks in both NMRs. Identify compounds A and B.

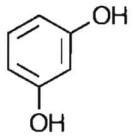
Both had –OH groups.

A – 4 peaks ^{1}H NMR ^{13}C NMR

B – 2 peaks ^{1}H NMR ^{13}C NMR



B



A

15. What is the molecular geometry of an alkynes like acetylene and a hydrogen cyanide
HC≡N HC≡CH

H–C≡C–H Linear and so is H–C≡N:

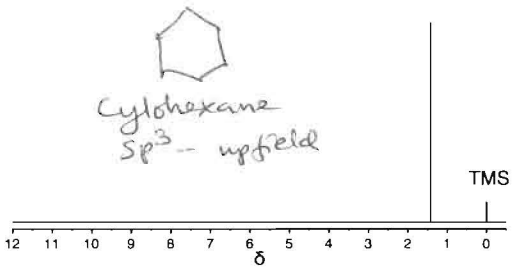
sp sp sp sp

16. How many hydrogens are there in an alkyne with 13 carbons? 24

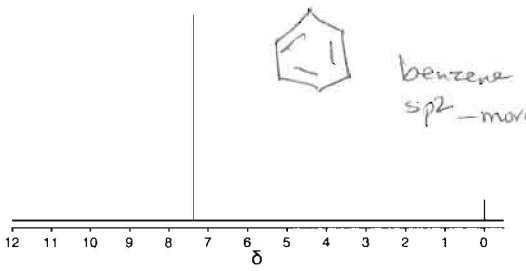
C_nH_{2n-2}

$C_{13}H_{(26-2)} = C_{13}H_{24}$

17. The ^{1}H NMR spectrum of benzene (C_6H_6) and cyclohexane (C_6H_{12}) are shown below. Match the spectra with the correct molecule.

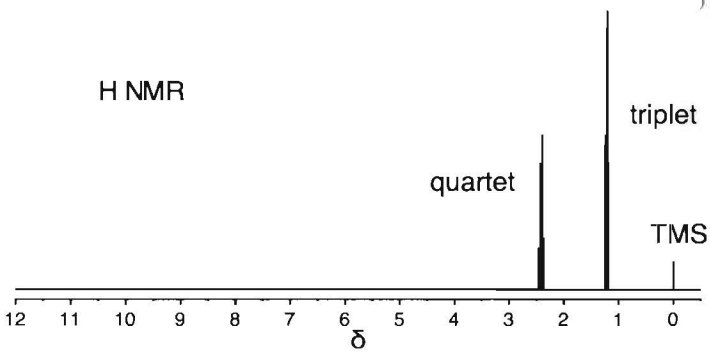


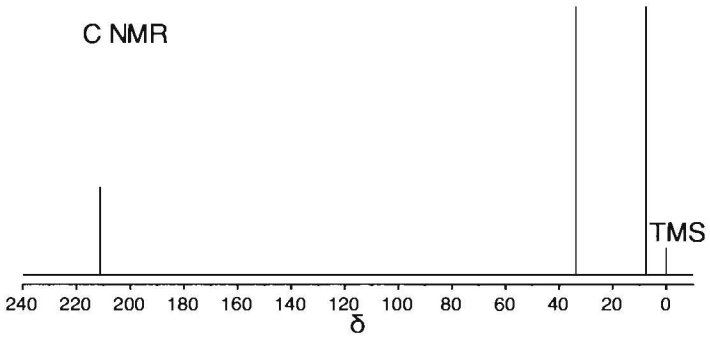
Cyclohexane
sp^3 -- upfield



benzene
sp^2 — more downfield

18. A compound, $C_5H_{10}O$, has an intense IR band at 1725 cm^{-1}. Its ^{1}H NMR and ^{13}C NMR are shown below. Deduce the structure of the compound.





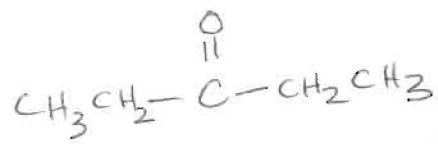
*) Strong IR band at 1725 cm^{-1} suggests a carbonyl group

*) triplet, quartet pattern in ^{1}H NMR suggests an ethyl group

$-CH_2CH_3$

• Three peaks in ^{13}C NMR suggests three types of Carbons

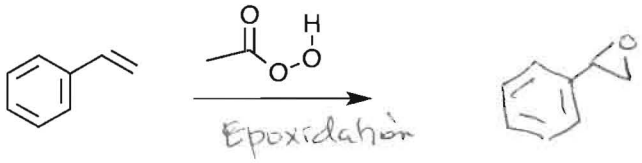
• from the molecular formula the structure of the compound is

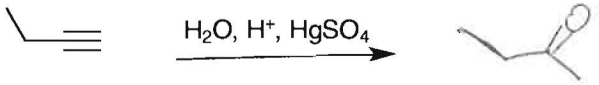


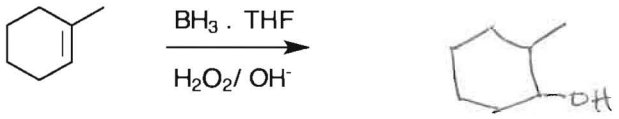
For questions 19-25, fill in the missing reagent(s) and the major product(s) for the following reactions

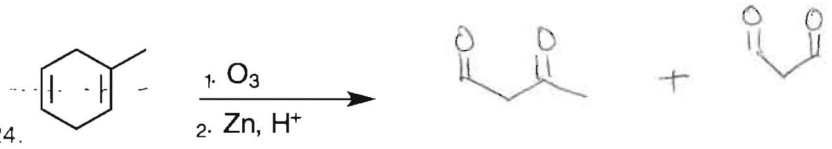
19. 

20. 

21. 

22. 

23. 

24. 

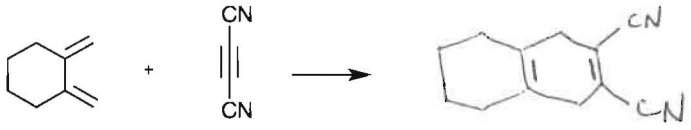
25. 

Table 12.2 Typical ^1H Chemical Shifts (Relative to Tetramethylsilane)

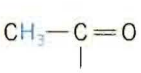
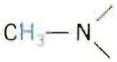
Type of ^1H	δ (ppm)	Type of ^1H	δ (ppm)
C—CH_3	0.85–0.95	—CH_2—F	4.3–4.4
C—CH_2—C	1.20–1.35	—CH_2—Br	3.4–3.6
		—CH_2—I	3.1–3.3
	1.40–1.65	CH_2=C	4.6–5.0
CH_3—C≡C	1.6–1.9	—CH=C	5.2–5.7
CH_3—Ar	2.2–2.5	Ar—H	6.6–8.0
	2.1–2.6	—C≡C—H	2.4–2.7
	2.1–3.0		9.5–9.7
CH_3—O—	3.5–3.8		10–13
—CH_2—Cl	3.6–3.8	R—OH	0.5–5.5
—$CHCl_2$	5.8–5.9	Ar—OH	4–8

Table 12.4 Infrared Stretching Frequencies of Some Typical Bonds

Bond type	Group	Class of compound	Frequency range (cm^{-1})
single bonds to hydrogen	C—H	alkanes	2850–3000
	=C—H	alkenes and aromatic compounds	3030–3140
	≡C—H	alkynes	3300
	O—H	alcohols and phenols	3500–3700 (free) 3200–3500 (hydrogen-bonded)
	O—H	carboxylic acids	2500–3000
	N—H	amines	3200–3600
	S—H	thiols	2550–2600
double bonds	C=C	alkenes	1600–1680
	C=N	imines, oximes	1500–1650
	C=O	aldehydes, ketones, esters, acids	1650–1780
triple bonds	C≡C	alkynes	2100–2260
	C≡N	nitriles	2200–2400