

# CHEM 341

Instructor: Dr. Sachin Handa

## Practice Exam I

Last Name: Answer Key

First Name: \_\_\_\_\_

### Please carefully read these instructions

- Each question has subparts; you need to correctly answer all subparts to get full points.
- There will be four different types of exams with same difficulty level (e.g. type A, B, C, D) and it is possible that the student next to you has a different exam.
- There is ZERO TOLERANCE FOR CHEATING.
- Extra scratch sheets will be provided upon request.
- Calculator is not allowed in exam.

Question 1.

(12 pts)

1a) Write 'true' or 'false' in a box

4 pts

i) Benzene has three  $\pi$ -electrons

F

ii) Hybridization in the  $\text{BF}_3$  molecule is  $\text{sp}^3$

F

iii) HF is more acidic than HCl

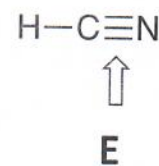
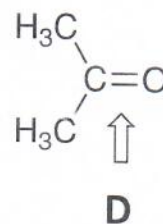
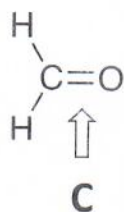
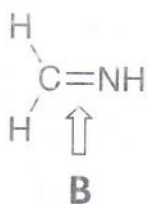
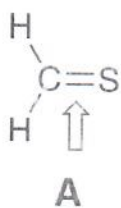
F

iv)  $\text{CF}_3\text{Cl}$  has zero net dipole moment

F

1b) Arrange in increasing order of bond length (shortest first).

2 pts



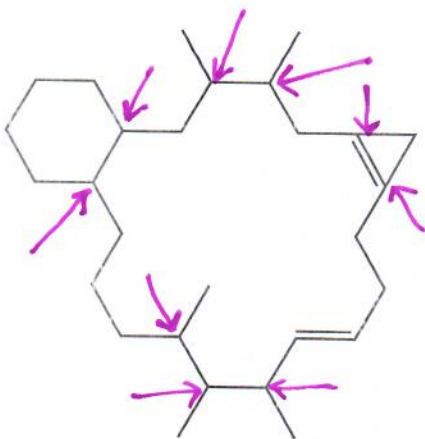
shortest

longest

E	C	D	B	A
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1c) Circle all tertiary carbons in the following molecule

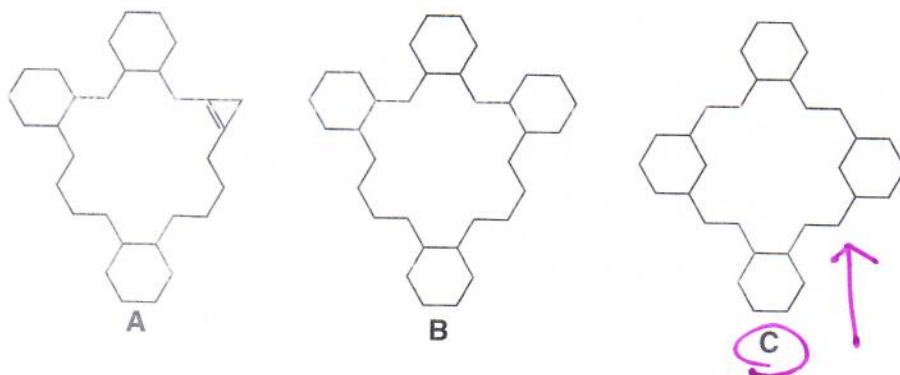
3 pts



Total 9 tertiary carbons

1d) Which compound has the highest boiling point? Explain why.

3 pts



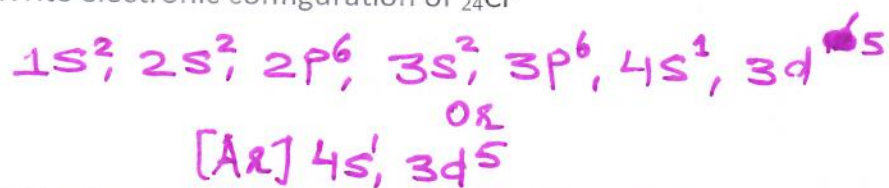
All compounds have only VanderWalls forces. However, compound c is more symmetrical than 'A' and 'B'. Therefore its packing will be more tight and boiling point will be more.

Question 2. Answer the following:

(10 pts)

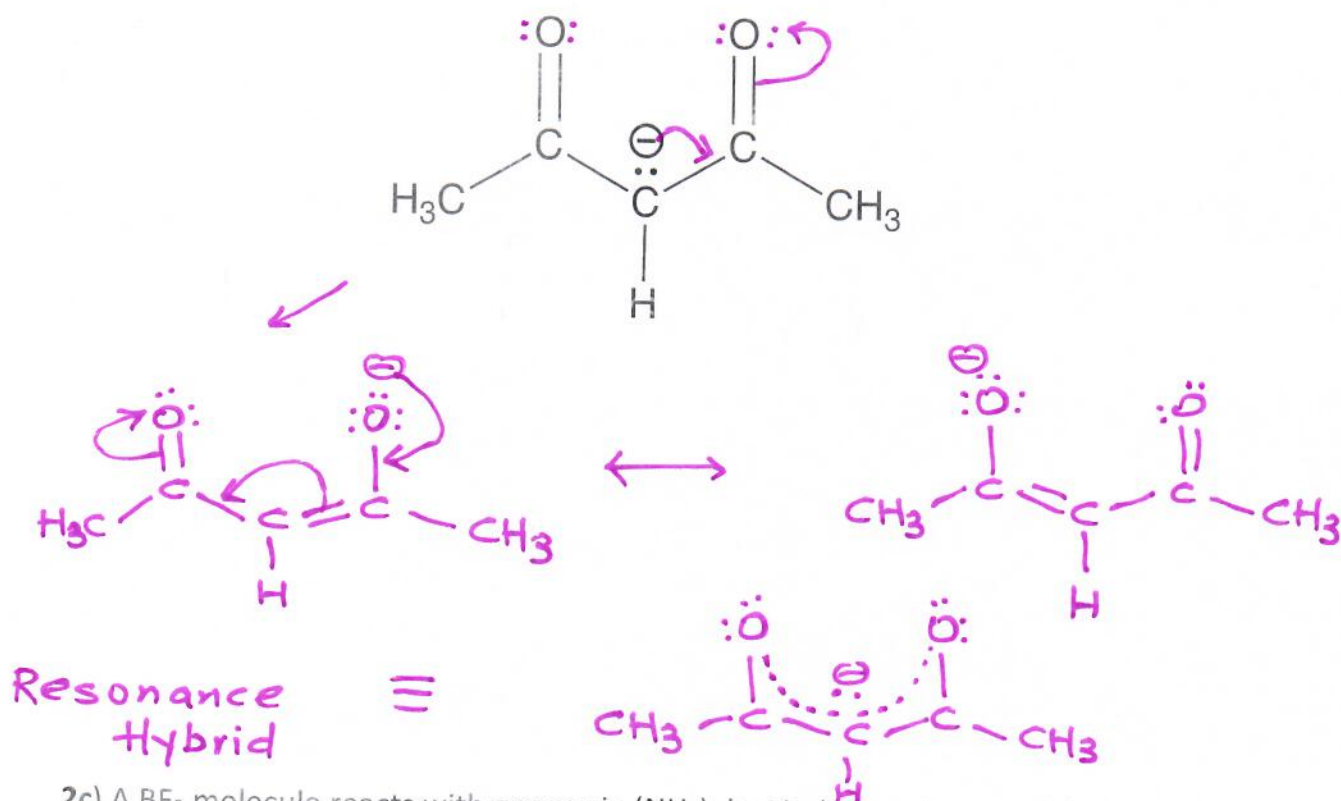
2a) Write electronic configuration of  ${}_{24}\text{Cr}$

2 pts



2b) Write the resonance structures of the following compound.

3 pts



2c) A  $\text{BF}_3$  molecule reacts with ammonia ( $\text{NH}_3$ ), but it does not react with methane ( $\text{CH}_4$ ). Why? (Hint: draw Lewis structures of  $\text{BF}_3$ ,  $\text{NH}_3$ , and methane and find the hybridization of  $\text{BF}_3$ )

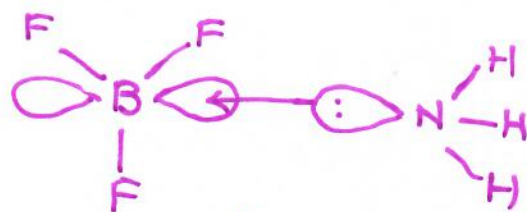
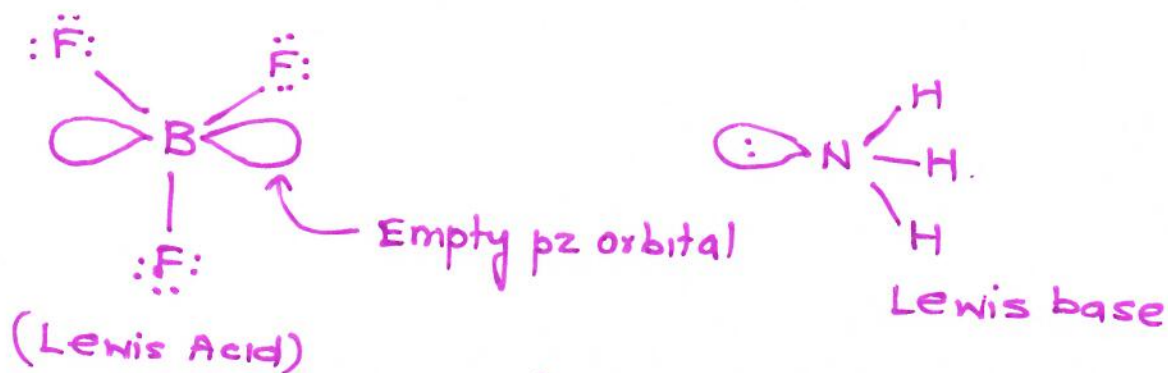
5 pts

See next page

$\text{BF}_3 = 24$  valence electrons

Hybridization =  $sp^2$

Geometry = Linear



"Acid-base complex to complete octet of boron"

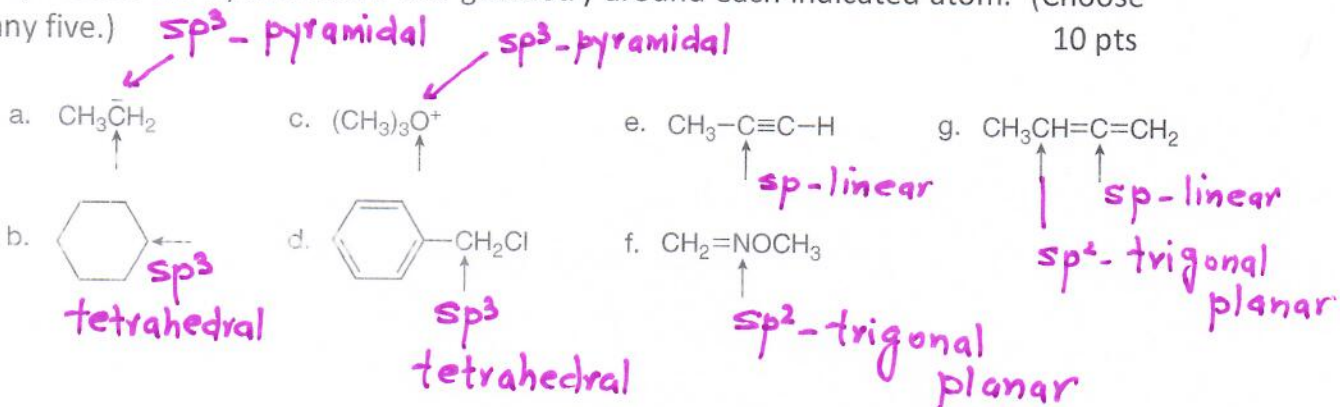
$\text{BF}_3$  has a boron atom with vacant  $p_z$  orbital.  $\text{NH}_3$  has a lone-pair  $e^-$  that can complete the octet of boron by electron donation.

$\text{CH}_4$  does not have any lone pair to donate, i.e., neither Lewis acid nor Lewis base.

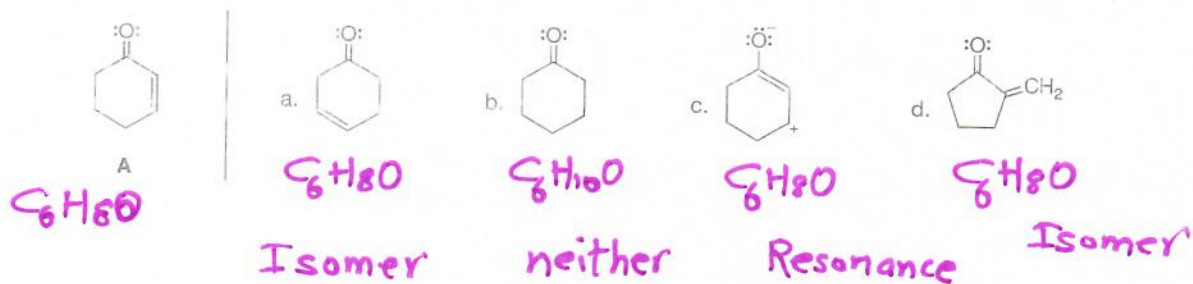
Question 3. Answer the following

(16 pts)

3a) Predict the hybridization and geometry around each indicated atom. (Choose any five.) 10 pts



3b) With respect to compound A drawn below, label each compound as "isomer," "resonance structure," or "neither" 4 pts





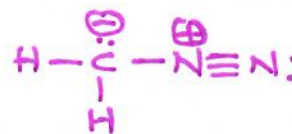
3c) Draw the Lewis structures of these molecules. (Choose any two) 2 pts



valence e<sup>-</sup>

16

Lewis structure



24



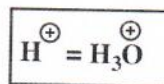
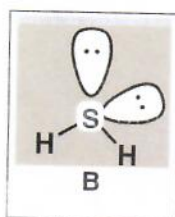
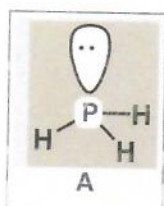
16



Question 4. Answer the following

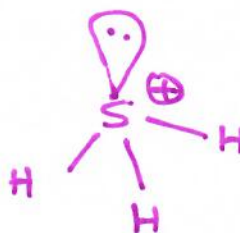
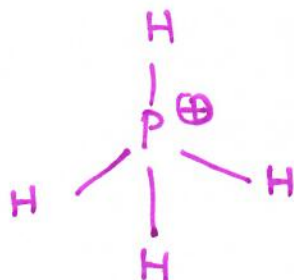
(10 pts)

4a) Compounds A and B react with a proton. Using acid-base chemistry, draw the structure of X and Y with correct their geometry. 6 pts



X

Y



4b). Between  $\text{PH}_3$  and  $\text{X}$ , which has a smaller H-P-H bond angle? Why? 4 pts

$\text{PH}_3$  has a smaller H-P-H angle due to lone pair - bond pair repulsions, which are stronger than bond pair - bond pair repulsions.

Question 5. Define any five terms:

(5 x 2 = 10 pts)

i) Hybridization

"Phenomenon of intermixing of orbitals of same or slightly different energy in order to generate same # of orbitals having same size, shape, and energy."

ii) Ionization energy

• Amount of energy required to remove most loosely bound electron.

iii) ~~Electron affinity~~ Electronegativity

"Tendency to attract shared electron pair"

iv) ~~Electronegativity~~ Electron Affinity

Amount of energy released when electron is added to the outermost orbit/shell.

v) Orbital

Space around the nucleus where probability to find electron density is maximum.



vi) Node

Space around nucleus where probability to find electron is zero.

vii) Lewis acid

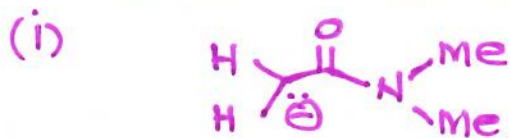
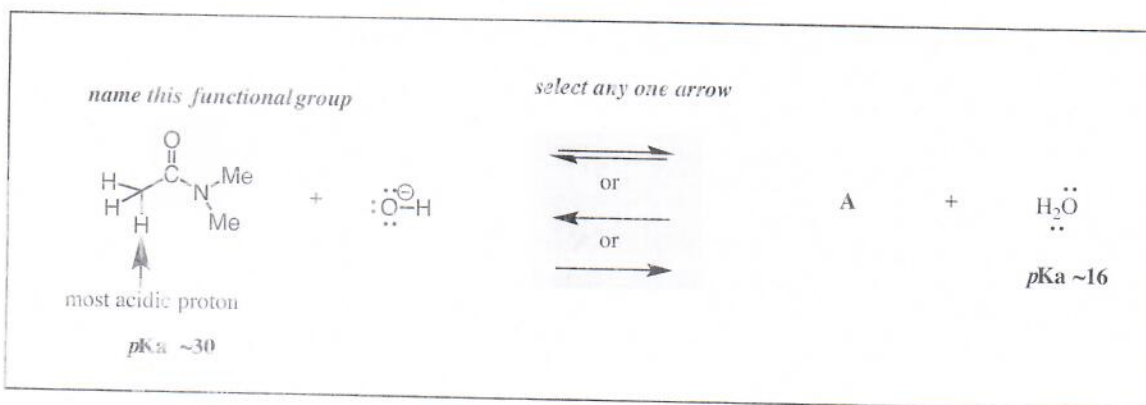
Electron pair acceptor.

Question 6.

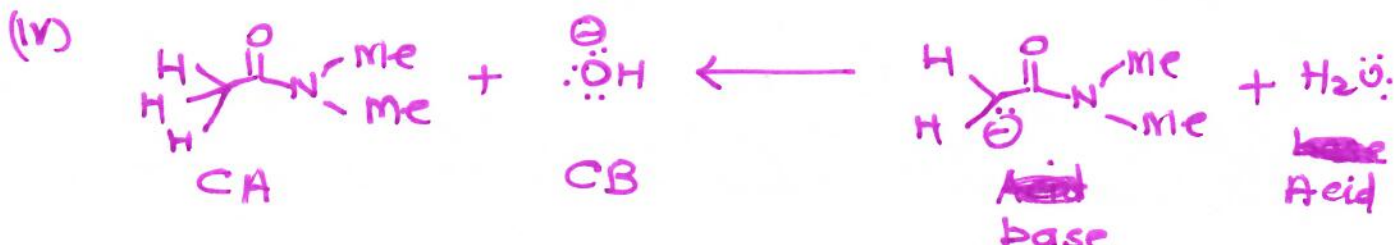
(12 pts)

In the reaction shown in the box below:

- Write structure of product A.
- Based on pKa value, select the correct arrow.
- Explain the reason why you picked that specific arrow.
- Label the base and conjugate acid.



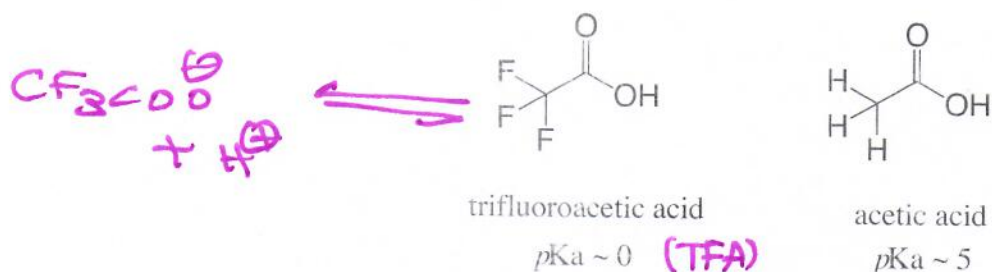
(iii) pKa of H<sub>2</sub>O is more; therefore, it is strong acid.



Question 7:

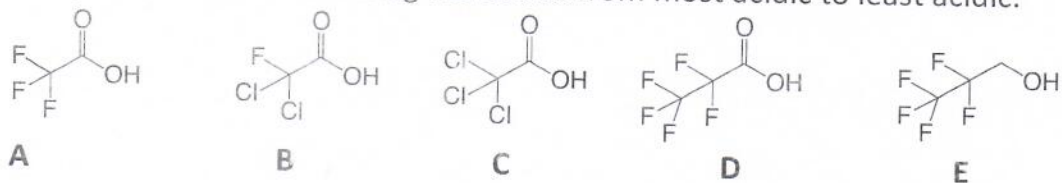
(2 x 5 = 10 pts)

i) Why is trifluoroacetic acid (TFA) a stronger acid than acetic acid?



TFA has three F atoms next to carbonyl. F atoms exhibit strong -ve-I effect due to high electronegativity of fluorine. Therefore -ve charge is more stabilized in TFA

ii) Order the following molecules from most acidic to least acidic.



most acidic

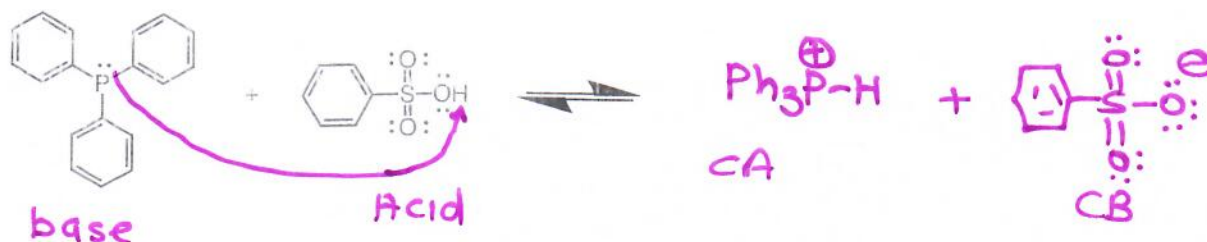
least acidic

D	A	B	C	E
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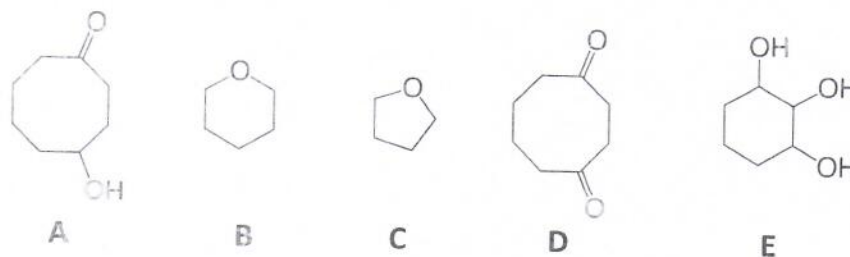
Question 8

(12 pts)

8a) Draw the products of the reaction and also label an acid, a base, a conjugate acid, and a conjugate base in the equation: (6 pts)



8b) Order the following compounds by boiling point. (From highest boiling to lowest boiling.) (6 pts)



highest boiling

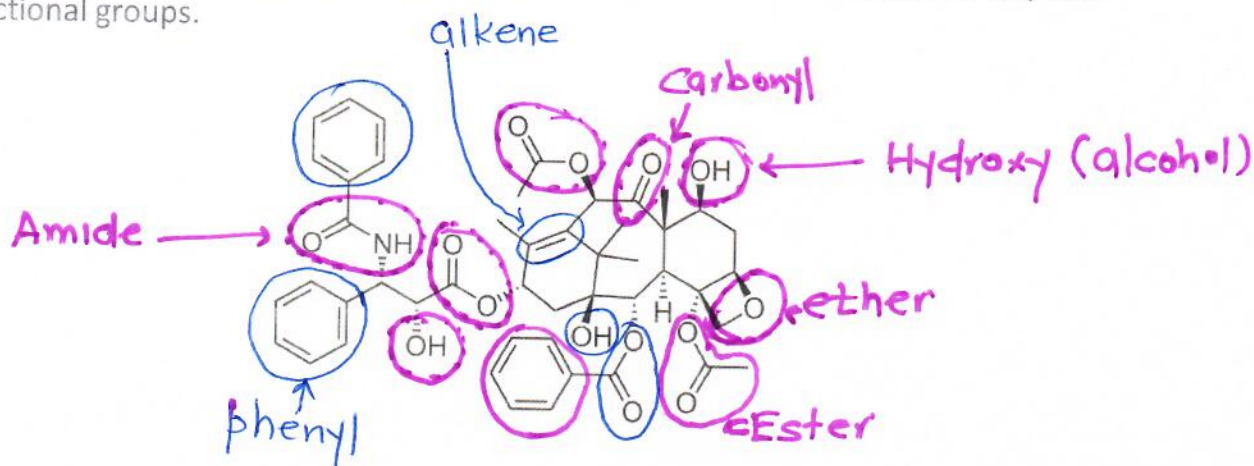
lowest boiling

E	A	D	B	C
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Question 9

(5+3=8 pts)

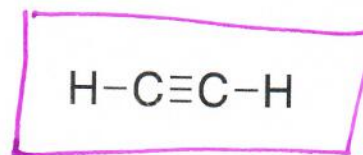
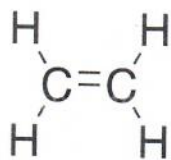
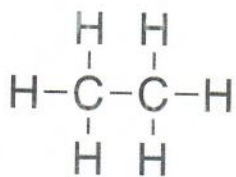
Circle all functional groups in following molecule and write the names of any two functional groups.



BONUS QUESTION

5 pts

Which of the following compounds is the most acidic? Explain why.



50% s-character, electrons are close to the nucleus and after abstracting  $\text{H}^+$ , -ve charge is more stabilized.

