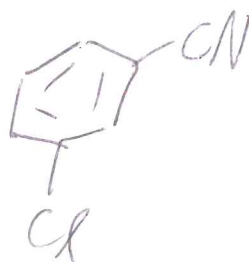
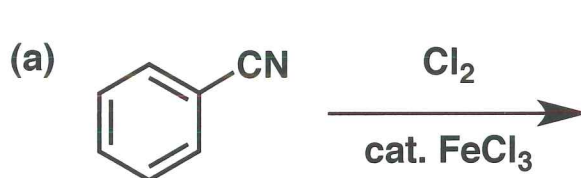


General Instructions:

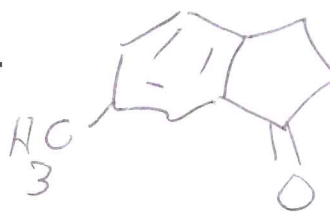
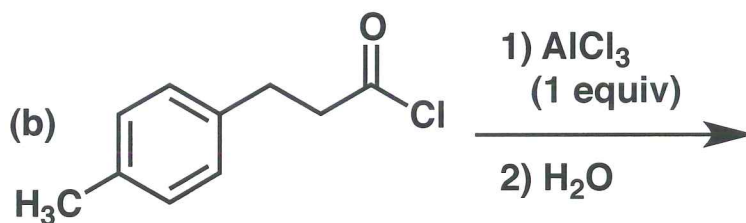
- (i) Use scratch paper at back of exam to work out answers; final answers must be recorded at the proper place on the exam itself for credit. Models are allowed.
- (ii) Print your name on each page.
- (iii) Please keep your paper covered and your eyes on your own work. No electronic devices may be used. Misconduct will lead to failure in the course.

1. (18 points) Show the product(s) expected from the reactions indicated below.

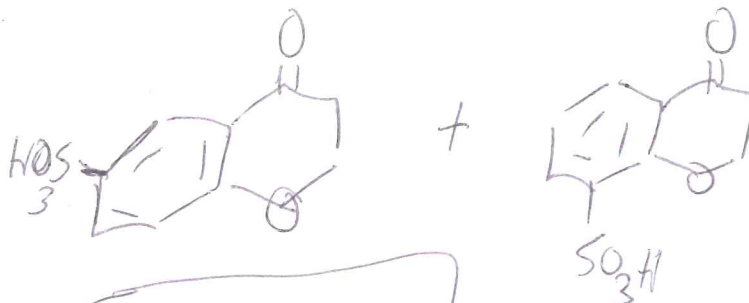
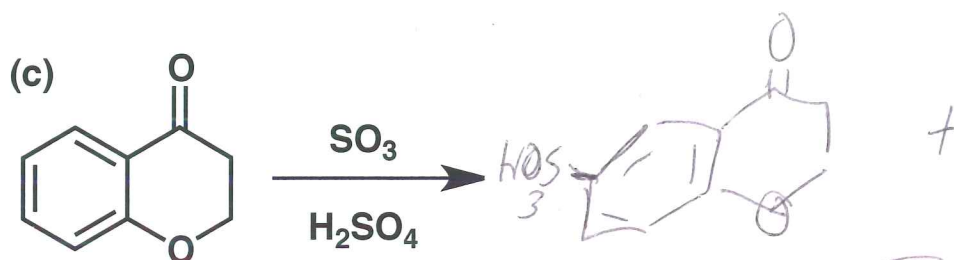


(+5)

-1 for extra red/or
incorrect structures



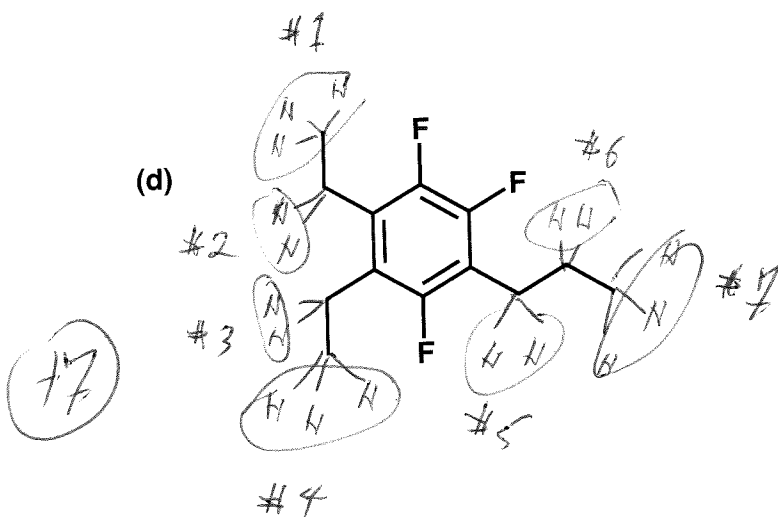
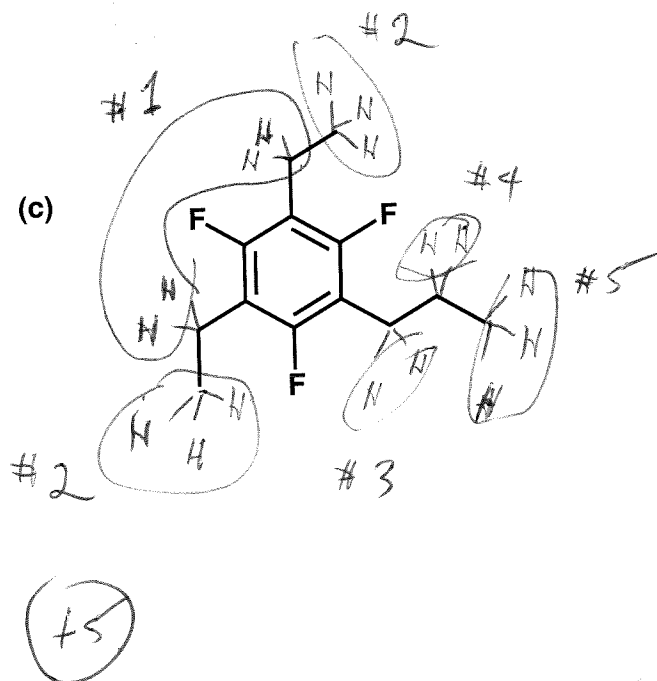
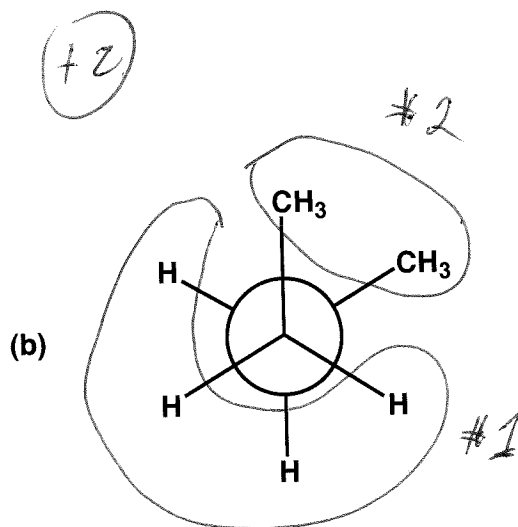
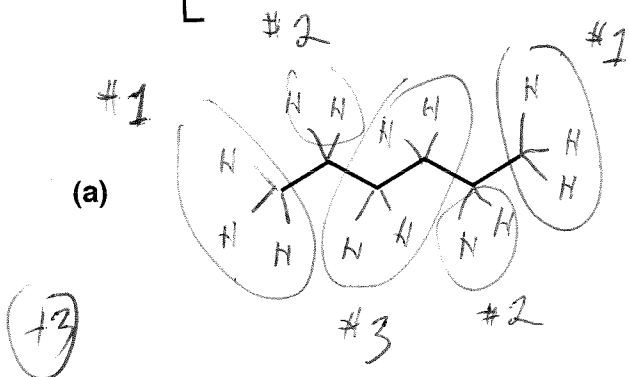
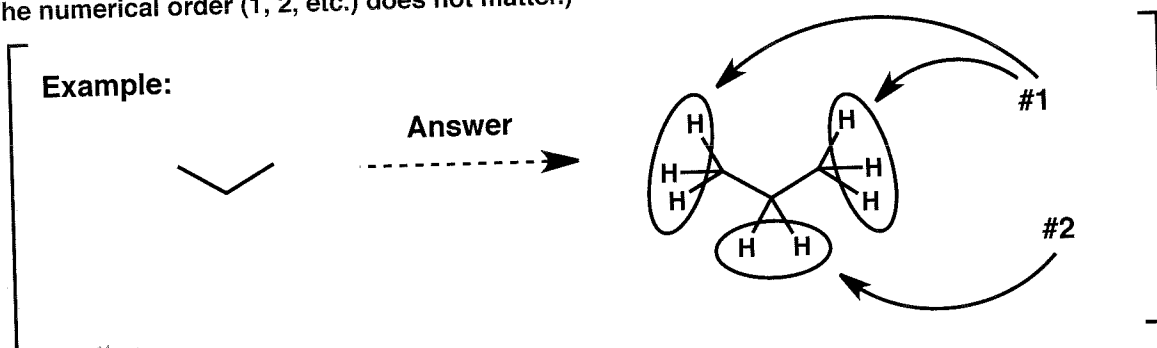
(+6)



+5 for one;
+7 for both

2. (17 points)

For each molecular drawing below, put a circle around sets of H atoms that you expect to be NMR-equivalent to one another (achiral solvent). In many cases you will have to draw in the H atoms yourself. Designate sets of non-equivalent H atoms as "#1", "#2", etc., as illustrated in the example below (propane). (Note: The numerical order (1, 2, etc.) does not matter.)



Name _____

3. (14 points)

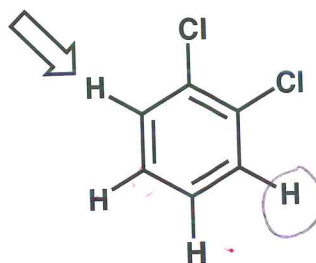
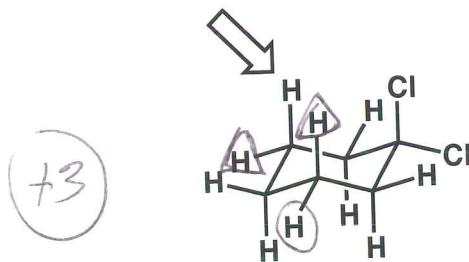
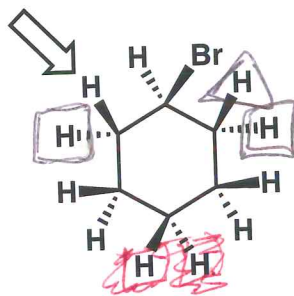
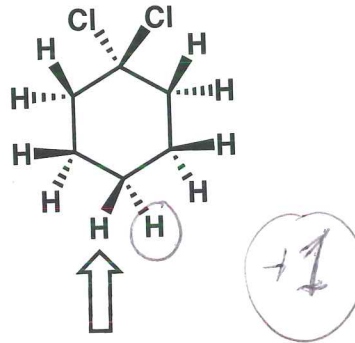
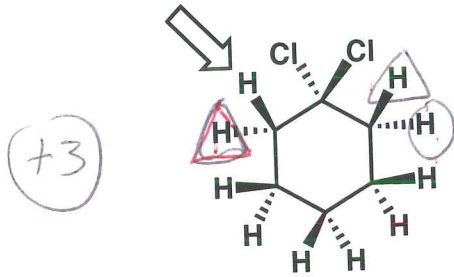
For each molecule drawn below, with reference to the H indicated by the arrow, label other H's as indicated...

...Put a CIRCLE around any homotopic H's.

...Put a TRIANGLE around any enantiotopic H's.

...Put a SQUARE around any diastereotopic H's.

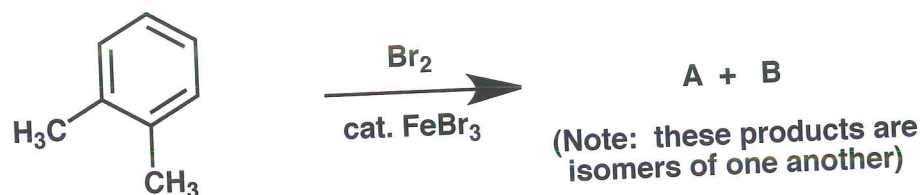
(Be sure to label only those H's that are appropriate.)



-1 for each "extra" symbol

Name _____

5. (12 points) Propose a structure for products A and B formed in the reaction shown below. Your proposal should be consistent with the available data.



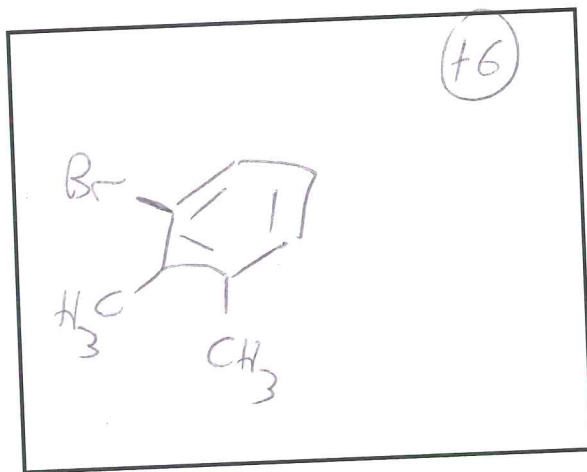
The ^1H NMR spectrum of this molecule has the following features:

A singlet $\delta 2.3$

Two doublets in the range $\delta 7-8$, coupling constant ~ 8 Hz.

Singlet integration 3x larger than each doublet integration.

A =



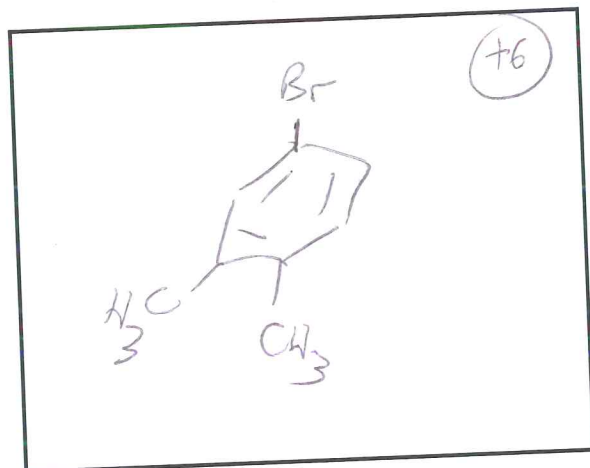
^1H NMR spectrum includes the following:

Two singlets near $\delta 2.3$, 1:1 integration

Three resonances in the range $\delta 7-8$, each a doublet-of-doublets. For one, both coupling constants are large (~ 8 Hz); for the other two, one coupling constant is large (~ 8 Hz) and the other is small (~ 1 Hz).

[+6 total if A & B are reversed]

B =



^1H NMR spectrum includes the following:

Two singlets near $\delta 2.3$, 1:1 integration

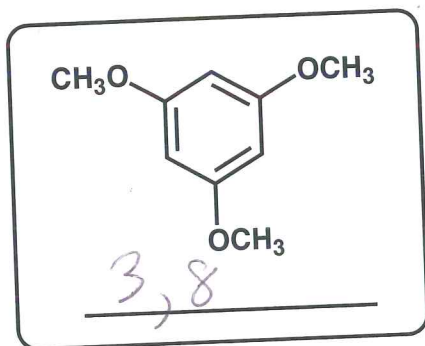
Three resonances in the range $\delta 7-8$. Two are doublets, one with a large coupling constant (~ 8 Hz) and the other with a small coupling constant (~ 1 Hz). The third is a doublet-of-doublets, with one large coupling constant (~ 8 Hz) and one small (~ 1 Hz).

Name _____

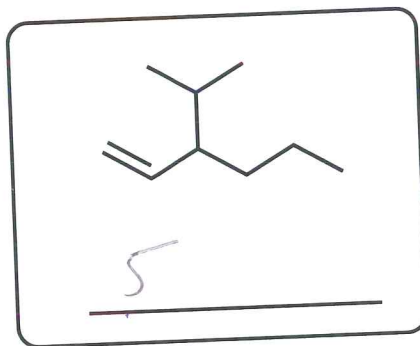
6. (15 points) For each of the molecules drawn below, place as many of the indicated numerals as appropriate on the line below the structure

- 1 = IR spectrum contains a strong signal at 1710 cm^{-1}
2 = ^{13}C NMR spectrum contains exactly 2 resonances
3 = ^{13}C NMR spectrum contains exactly 3 resonances
4 = ^{13}C NMR spectrum contains exactly 7 resonances
5 = ^{13}C NMR spectrum contains exactly 9 resonances
6 = ^{13}C NMR spectrum contains one and only one resonance at $\delta > 200$
7 = All ^1H resonances ~~at~~ ^{are} at $\delta < 3.0$
8 = The only kind of resonance in the ^1H NMR spectrum is a singlet
9 = ^1H NMR spectrum contains only one triplet and one quartet

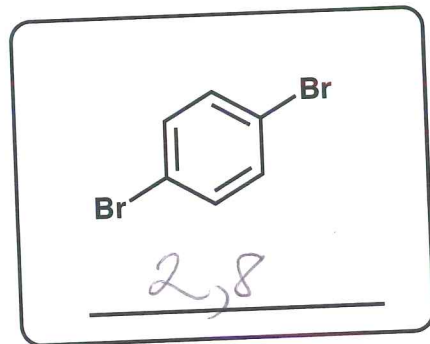
Extra #'s = -1



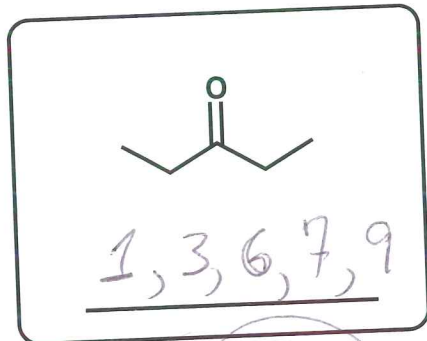
(+1) (+1)



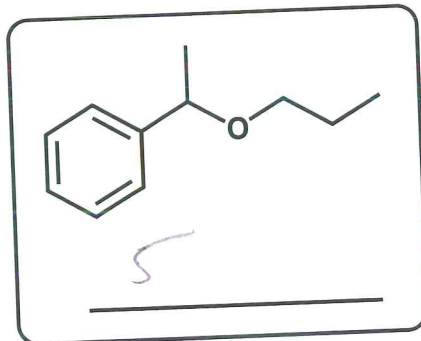
(+2)



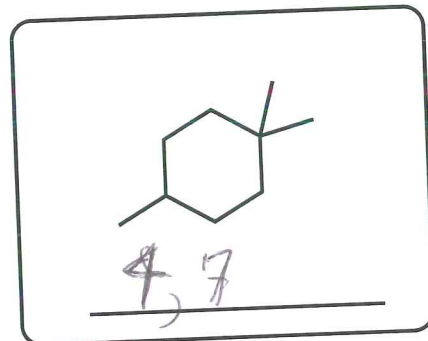
(+1) (+1)



+1 each



(+1)

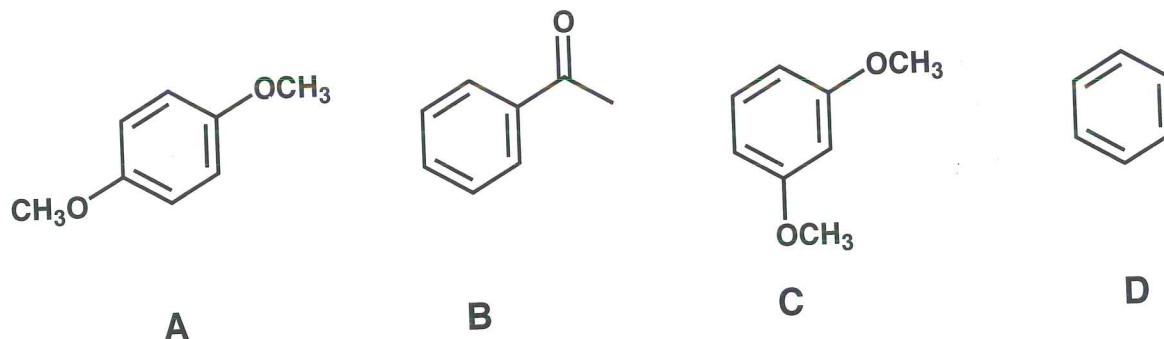


(+2) (+1)

Name _____

7. (12 points) For each set of four molecules shown below, rank them in order of INCREASING reactivity for an electrophilic aromatic substitution reaction (e.g., chlorination).

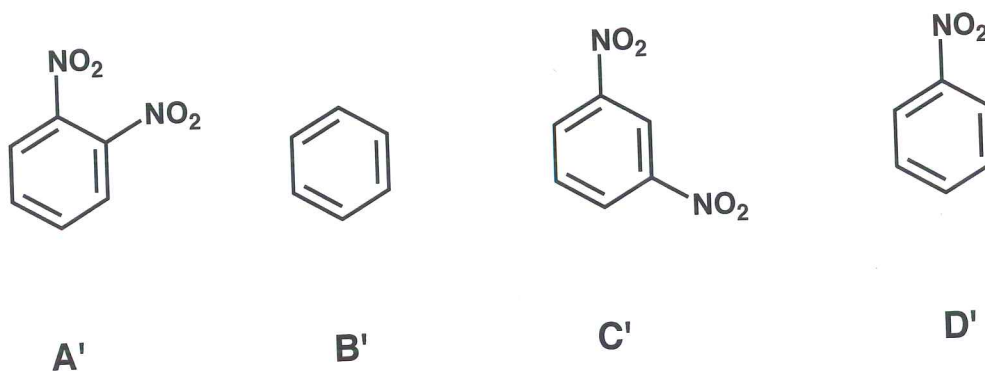
(a)



EAS reactivity increases in the order: B < D < A < C (+6)

[+3 for these 2]

(b)



EAS reactivity increases in the order: A' < C' < D' < B' (+6)

[+3 for these 2]