Chemistry 301X -- Hour Examination #1, Monday, October 16, 7:30-10 pm

"I beseech you, in the bowels of Christ, think it possible you are mistaken."

Oliver Cromwell

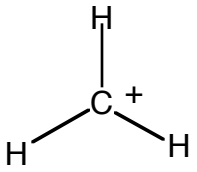
1 (18 points). Draw all the cyclic isomers of the formula C_6H_{12} *that are cyclopropanes*. Be alert for isomerism of the cis/trans and *R/S* types.

Indicate one isomer that has six different carbons, one that has five different carbons, one that has four, and one that has only two.

Draw one isomer - only one - showing the *S* configuration at one carbon.

2 (20 points).

(a) The ethyl cation (**1**) is more stable than the methyl cation (**2**). Why? What difference can the replacement of one H by methyl make? To answer this question, good three-dimensional drawings are surely necessary. Newman projections are probably the best way to look at the ethyl cation, so draw one, looking from the methyl group toward the positive carbon.



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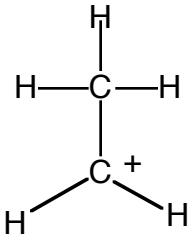

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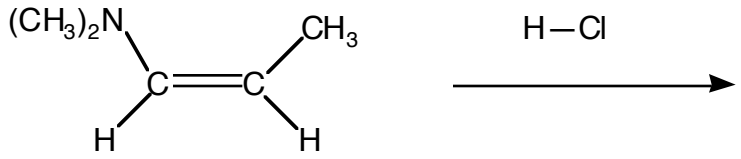
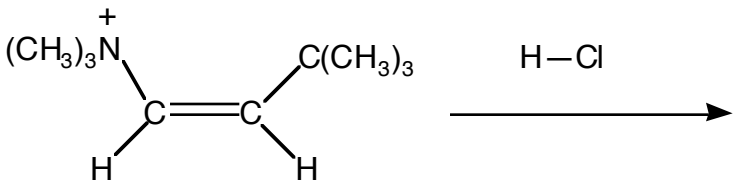
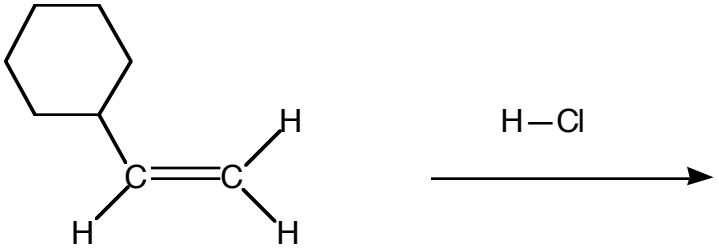
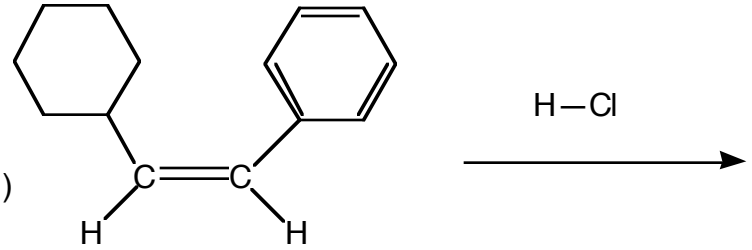
(b) Draw a reasonable resonance form for **1**.

3 (30 points). Here are some reactions. Give the product and draw arrow formalisms for product formation. If there is no reaction possible, say “no reaction.” Full Lewis structures are not drawn in this question, so your very first task to to flesh out these skeletal drawings by adding dots as appropriate. When there is choice - when two products are seemingly possible, tell us - very briefly - why you pick the one you do.

(a) 

(b) 

(c) 

(d) 

(e) $^{-}BH_4$ BH_3 ⟶

(f) $^{-}NH_2$ BH_3 ⟶

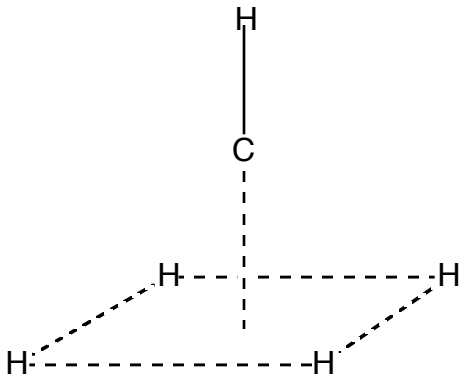
4 (32 points). Despite one's instinctive (?) aversion to "carbon attached to five things," such species are really very common. Methane, CH_4, can be protonated to give $^+CH_5$ for example. Let's imagine making the MOs for such a species by first constructing methine, CH, and then letting our CH approach the MOs for square H_4.

(a) Construct an orbital picture for CH from the AOs of C and the AO of H. For this part, draw out the starting AOs. Then show us the possible interactions, and the MOs coming from them. Then draw the C—H bond as a line, and add the unused AOs to generate a picture of methine. Please note that this is not a hybridization question - it could be written that way, but it is not.

Now, with CH in hand:

(b) Draw the MOs for square H_4. You may draw them from memory or make them if needed. Order them in energy.

Now, drop your CH down from the top, right in the middle of the square, **stopping somewhere *above* the plane of the square**. The dotted lines in the picture are just to show you where the atoms are. The solid line is a bond, the CH bond you made in part (a).



(c) Now, make the MOs for this CH_5 by interacting the appropriate orbitals for CH with the MOs for square H_4.

Show the MOs you are going to interact, and the new MOs that result from these interactions.

Order the bonding - only the bonding - MOs in energy.

Place the appropriate number of electrons for $^+CH_5$ in the orbitals.

"I pledge that I have not violated the Honour Code on this examination."