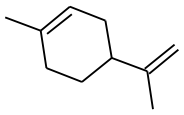
You will have one like each of the following, but with fewer a, b, c, etc. The raw points will be converted into 15% of your semester grade. You will be able to use your model kit, if you need it.

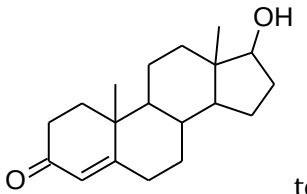
1. For each of the following elements, determine the number of valence electrons and the common number of covalent bonds it will have.
   a. O
   b. H
   c. S

2. Draw structural isomers for the five isomers of hexane. As you write them, try to be systematic, starting with a consecutive chain of six carbon atoms.

3. What is the molecular formula for each of the following compounds:

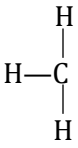
   a.  benzene

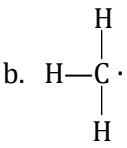
   b.  limonene

   c. 

testosterone

4. Consider the following highly reactive carbon species. What is the formal charge on carbon in each species?

   a. 

   b. 

5. Write a structural formula that corresponds to the molecular formula C_4H_8O and is
   a. acyclic
   b. carbocyclic

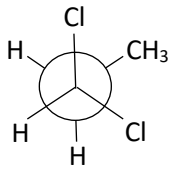
6. Give both common and IUPAC names for the following compounds:
   a. CH_3Br
   b. CH_3CH_2I
   c. CH_2Cl_2
   d. $(CH_3)_2CHI$

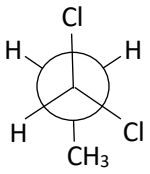
7. Write a structure for each of the compounds listed. Explain why the name given here is incorrect, and give a correct name in each case.
    a. 2,3-dibromopropane
    b. 1-methylbutane
    c. 2-ethylbutane

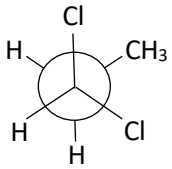
8. Without referring to tables, arrange the following five hydrocarbons in order of increasing boiling point. Explain your answers in terms of intermolecular interactions. *(Hint: Draw structures or make models of the five hydrocarbons to see their shapes and sizes.)*
    a. 2-methylhexane
    b. heptane
    c. 3,3-dimethylpentane
    d. hexane
    e. 2-methylpentane

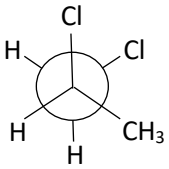
9. Draw Newman projections for two different *staggered* conformations of butane (looking end-on at the bond between carbon-2 and carbon-3). Then, draw Newman projections for two different *eclipsed* conformations of butane. Arrange these four conformations in order of decreasing stability.

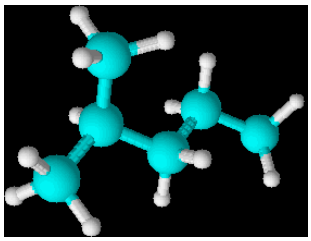
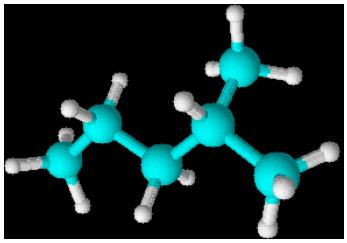
10. Explain with the aid of conformational structures why *cis*-1,3-dimethylcyclohexane is more stable than *trans*-1,3-dimethylcyclohexane. (*Constructing models will help you with this.*)

11. Examine the relationships of isomers as described in class. Then classify the following pairs of isomers as structural, conformational, configurational, or identical structures.
    a. the pair of compounds in #14
    b. 

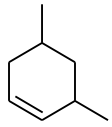
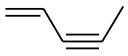
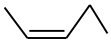
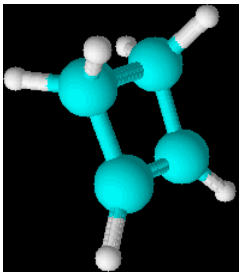
and 

    c. 

and 

    d. 
and 

12. From the dichlorination of propane, four isomeric products with the formula, $C_3H_6Cl_2$ were isolated and designated A, B, C, and D. Each was separated and further chlorinated to give one or more trichloropropanes, $C_3H_5Cl_3$. A and B gave three trichloro compounds, C gave one, and D gave two. Deduce the structures of C and D. One of the products from A was identical to the product from C. Deduce the structures for A and B. (*Hint: Start by drawing the structures of all four dichlorinated propane isomers.*)

13. Name the following compounds by the IUPAC system:
    a. $CH_3CH{=}C(CH_2CH_3)_2$
    b. $CH_3CH_2CH{=}CHCH_3$
    c. 
    d. $CH_3C{\equiv}CCH_2CH_2CH_3$
    e. $CH_2{=}CHCBr{=}CH_2$
    f. 
    g. 
    h.  (all H's are shown)

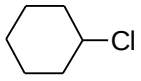
14. Write the structural formula for each of the following compounds:
    a. 1-hexene
    b. cyclopentene
    c. 1,3-dichloro-2-butene
    d. 4-methyl-2-hexyne
    e. 1,4-cyclohexadiene

15. Which of the following compounds can exist as *cis—trans* isomers? If such isomerism is possible, draw the structures in a way that clearly illustrates the geometry, indicating which is *cis* and which is *trans*.
    a. 3-hexene
    b. 1-pentene
    c. 1-bromopropene

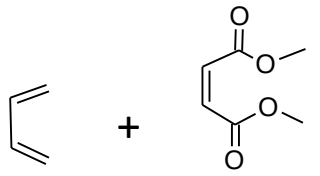
16. Sorbic acid is an antimicrobial agent used as a preservative to prevent the growth of mold, yeast, and fungi on food. Its formula is:

$$CH_3CH{=}CHCH{=}CHC{=}O$$
$$\qquad\qquad\qquad\qquad\quad |$$
$$\qquad\qquad\qquad\qquad\quad OH$$

    Is the molecule cumulated, conjugated, or nonconjugated?

17. What reagent will react by addition to what unsaturated hydrocarbon to form each of the following compounds?
    a. $CH_3CHBrCHBrCH_3$
    b. $(CH_3)_2CHOSO_3H$
    c. $(CH_3)_3COH$
    d. 

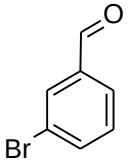
18. Predict and name the product of the following Diels-Alder reaction for the diene (left) and dienophile (right) as shown:

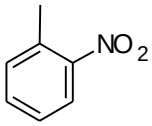


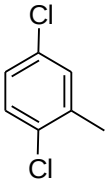
19. Write equations and names of products for the following reactions:
    a. 2-pentyne + H_2 (1 mol, Lindlar's catalyst)
    b. 3-hexyne + Cl_2 (2 mol)

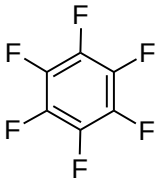
20. For the following compounds write the line structures:
    a. 1,3,5-tribromobenzene
    b. *o*-chlorotoluene
    c. *p*-diethylbenzene
    d. isopropylbenzene
    e. 2,3-diphenylbutane
    f. 2-bromo-4-ethyl-3,5-dinitrotoluene
    g. *m*-nitroanisole
    h. *m*-chlorobenzoic acid

21. Name the following compounds:

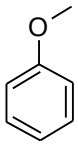
a. 

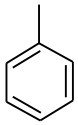
c. 

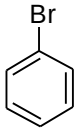
b. 

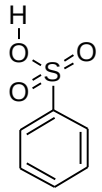
d. 

22. For each of the monosubstituted benzenes shown below indicate whether the substituent is *ortho, para*-directing or *meta*-directing and draw the structure(s) of the main monosubstitution product(s) for each of the reactions indicated:

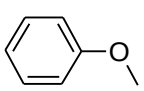
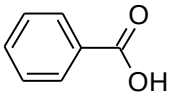
a.  + Cl_2 (Fe catalyst)

b.  + Br_2 (Fe catalyst)

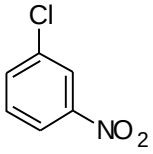
c.  + concentrated H_2SO_4 (heat) + SO_3

d.  + concentrated HNO_3 (H_2SO_4 catalyst)

23. Which compound is more reactive toward electrophilic substitution, i.e. nitration:

 or 

24. Using benzene or toluene as the only aromatic organic starting material, devise a synthesis for each of the following compounds and name the product:

a. 

b.