Chemistry 10123 and 10125, **Exam 5** **Answer Key**
April 29, 2009

1. Consider the following metal complexes, **A** - **D**.

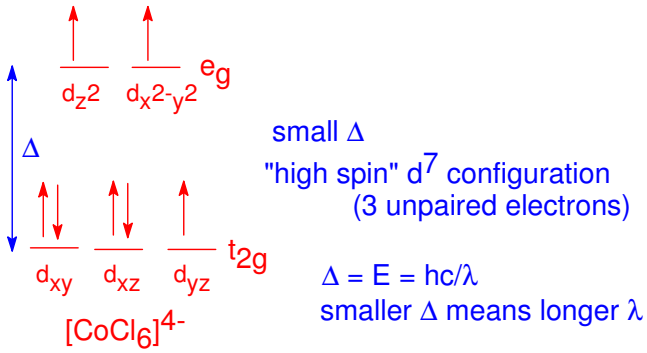
A: $[Co(en)_3]^{2+}$ **B**: $[Rh(CN)_6]^{3-}$ **C**: $[CoCl_6]^{4-}$ **D**: $Rh(H_2O)_6^{3+}$

(a) (3 points) Complex B should absorb light of shortest wavelength.

(b) (3 points) In complex **B**, the oxidation state of Rh is 3+ and the number of d electrons on the Rh ion is 6.

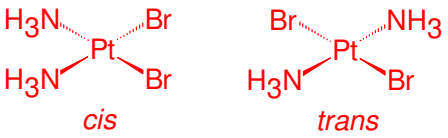
(c) (3 points) Three of these complexes are "low-spin" and one is "high-spin." The high-spin complex is C and it has 3 unpaired electrons.

(d) (4 points) Sketch an appropriately labeled ***d-orbital splitting diagram*** for the above ***high-spin complex*** that accounts for the number of unpaired electrons. Indicate on your diagram what feature is related to the wavelength of absorbed light.

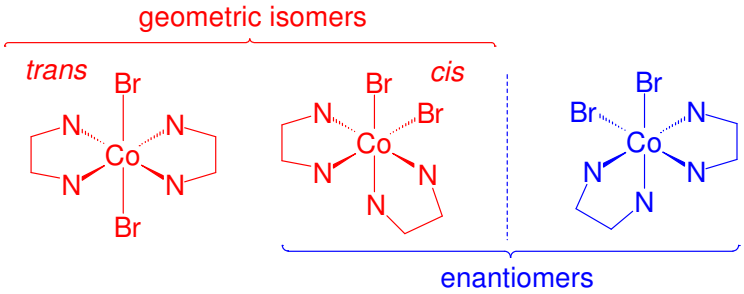


2. For each of the following metal complexes, draw clear, ***3-dimensional structures*** of all possible ***isomers*** (geometric and/or optical). Also, for each one, write the term that best describes the structure (i.e., tetrahedral, linear, etc.). (en = ethylenediamine) ***Points will be deducted if the same structure is drawn more than once!***

(a) (3 points) $Pt(NH_3)_2Br_2$ square planar



(b) (5 points) $Co(en)_2Br_2$ octahedral



3. (4 points) Write the systematic name of the compound: $[Mn(en)_2(NH_3)CN]_2SO_4$

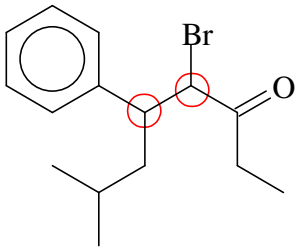
amminecyanobis(ethylenediamine)manganese(II) sulfate

4. (3 points) Which of the following complexes are capable of exhibiting ***linkage isomers***? **Circle your answers(s).** (en = ethylenediamine)

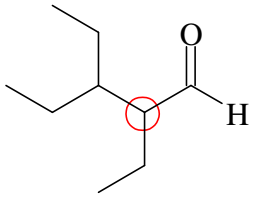
$[Cr(en)_2Br_2]^+$ $[Cr(en)_3]^{3+}$ $[Cr(NH_3)_5NO_2]^{2+}$ $[Cr(NH_3)_5Br]^{2+}$

$[Cr(en)_2(NH_3)OCN]^{2+}$ $[Cr(en)_2(C_2O_4)]^+$

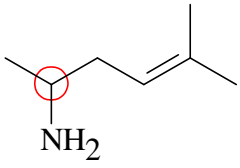
5. (12 points) Write the **complete, systematic name** of each of the following compounds.



4-bromo-7-methyl-5-phenyl-3-octanone



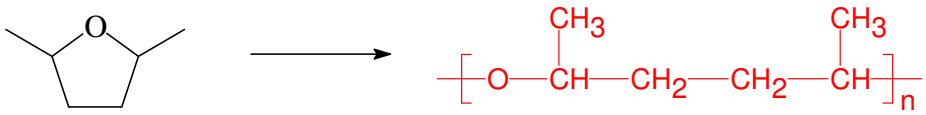
2,3-diethylpentanal



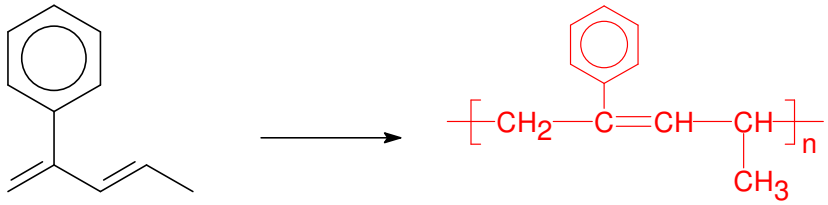
5-amino-2-methyl-2-hexene

6. (4 points) On each of the structures in question 5 above, circle any carbon atoms that are chiral centers. See circles above.

7. (8 points) Write ***complete structural formulas*** of the polymers that can be prepared from the following monomers. (You may use either expanded or condensed formulas but <u>all carbons, hydrogens, and functional groups must be clearly shown</u>.) Also, indicate whether the polymerization process is addition, condensation, or ring-opening.



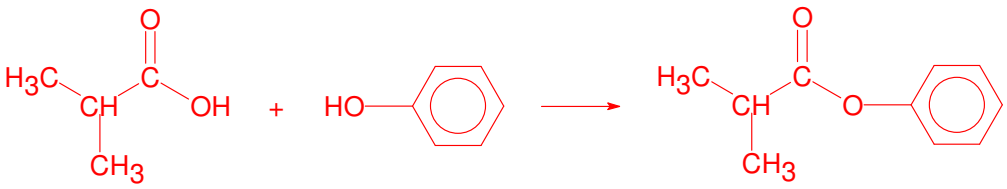
(a) type of polymerization: ring-opening



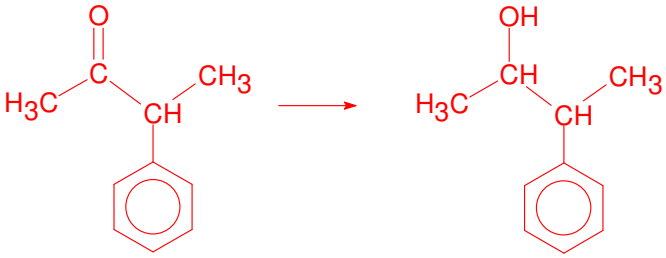
(b) type of polymerization: addition

8. (10 points) Write ***specific structural formulas*** for all of the organic compounds in the following reactions. (You may use either expanded or condensed formulas but <u>all carbons, hydrogens, and functional groups must be clearly shown</u>.)

(a) 2-methylpropanoic acid + phenol ⟶ an ester

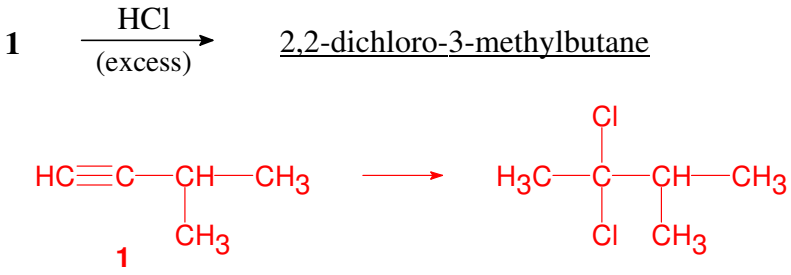


(b) a ketone $\xrightarrow{H_2}$ 3-phenyl-2-butanol

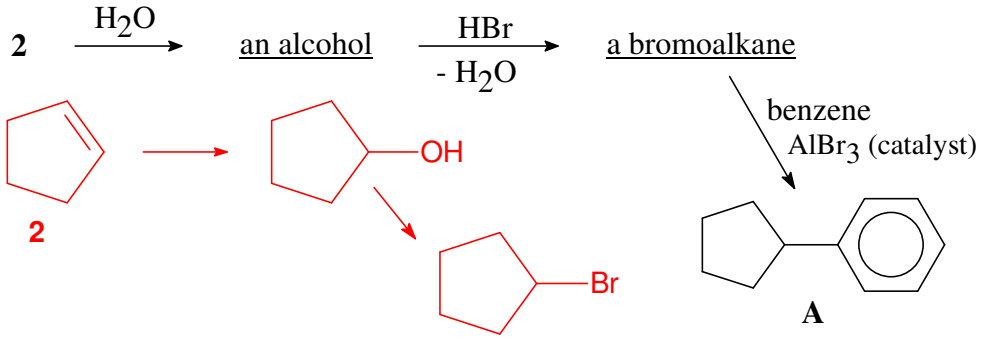


9. Surprisingly, there are more than 20 ***structural isomers*** of the simple hydrocarbon formula **C_5H_8**. Most of them contain multiple bonds and/or rings. Based on information provided in the following questions, identify ***ten specific isomers of*** **C_5H_8**, i.e., the compounds labeled **1** - **10**. (All ten structures are different!)
Specific structural formulas are required for compounds **1** – **10** and for all other organic compounds that are ***underlined***.

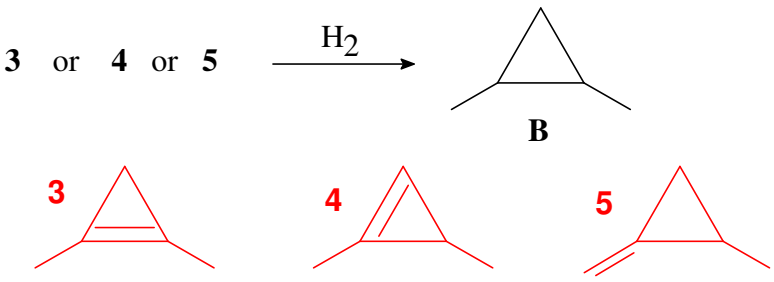
(a) (5 points) Compound **1** reacts with ***excess*** HCl as follows.



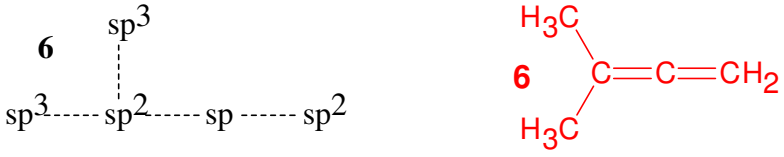
(b) (7 points) Compound **2** adds water to form an alcohol which can then be converted into a bromoalkane and, finally, the aromatic hydrocarbon **A**.



(c) (6 points) Compounds **3**, **4**, and **5** can all be hydrogenated to produce the *cyclo*propane product **B**. Draw structures of isomers **3** - **5**.

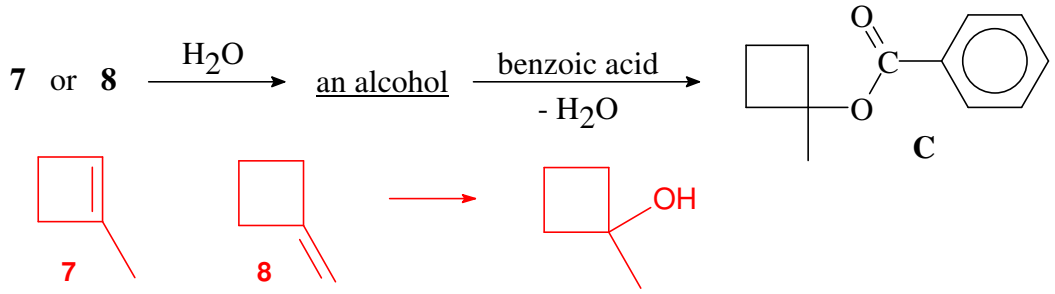


(d) (3 points) Compound **6** has a branched structure in which the hybridization at the carbon atoms occurs in the following order.

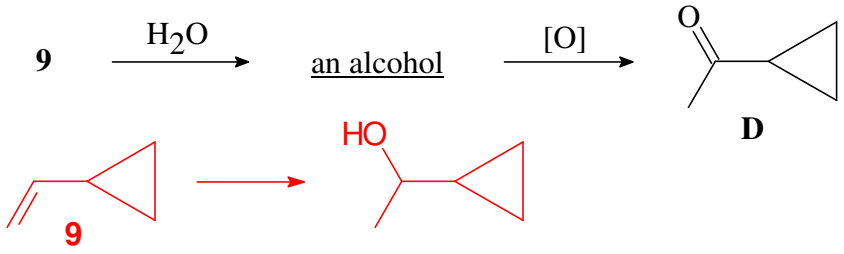


9. continued.....more C_5H_8 isomers!

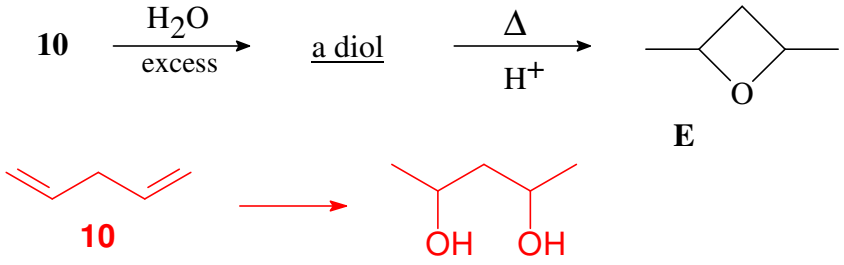
(e) (7 points) Compounds **7** or **8** can both add water to form the same alcohol that, in turn, reacts with benzoic acid to produce compound **C**.



(f) (5 points) Compound **9** adds water to form an alcohol that, in turn, can be oxidized to produce compound **D**.



(g) (5 points) Compound **10** reacts with an ***excess*** of water to give a diol. When this diol is heated with a catalytic amount of sulfuric acid, compound **E** is produced.



(h) **EXTRA CREDIT.** (4 points max) There are some possible isomers of C_5H_8 that contain ***no multiple bonds***. Write "stick" formulas for as many of these molecules as possible. (***Note***: Points will be deducted for duplicate structures!)