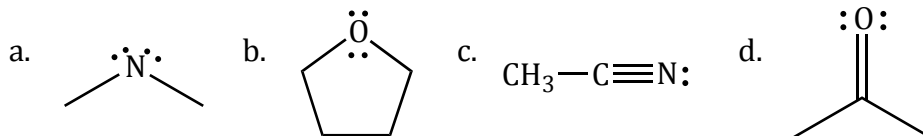


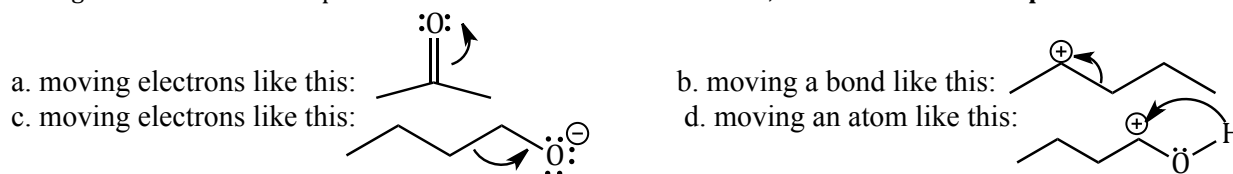
Multiple Choice (60%; 2% each)

Please mark the letter of the BEST answer to each question clearly on your answer sheet. Thanks!

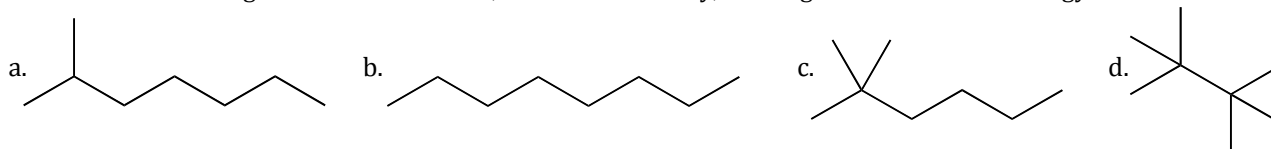
- Which of the following substances is most likely to have **ionic bonding** between the atoms that form it?  
a. CH<sub>3</sub>OH      b. BBr<sub>3</sub>      **c. KF**      d. SeBr<sub>2</sub>
- Carbon displays many types of bonding in its millions of compounds. Which statement is true of carbon?  
**a. it forms four bonds**    b. it rarely forms multiple bonds    c. C-to-F bonds are weak    d. C-to-C bonds are weak
- Which of the following species has a **negative formal charge** on at least one of its atoms? **Answer a**



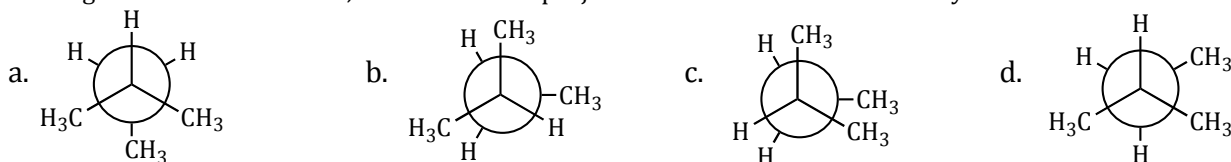
- Among Klein's rules & examples of *resonance* electron arrow errors, which of these is **acceptable**? **Answer a**



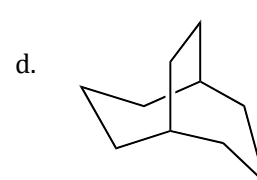
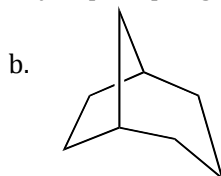
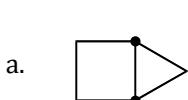
- Which is a molecule that is likely to have a significant **dipole moment**?  
a. CO<sub>2</sub>      **b. CH<sub>3</sub>Cl**      c. CCl<sub>4</sub>      d. CH<sub>4</sub>
- How many structural (constitutional) isomers of C<sub>3</sub>H<sub>4</sub> would there be? **a. 3**    b. 2    c. 4    d. only 1
- What orbitals are overlapping to form the C-C bond of ethane, using the usual valence bond concepts?  
a. 2s + 2p      b. 2 x 2p      **c. 2 x sp<sup>3</sup>**      d. 2 x sp<sup>2</sup>
- Which of these is a constitutional isomer of hexane?  
**a. 3-methylpentane**    b. cyclohexane    c. 2,2-dimethylpropane    d. 1,4-dimethylbutane
- The main intermolecular forces in pure alkanes are  
a. dipole-dipole      **b. London (dispersion)**    c. dipole-induced dipole    d. hydrogen bonding
- Incomplete** combustion of hydrocarbons produces  
**a. CO or soot**      b. CO<sub>2</sub>      c. H<sub>2</sub>O<sub>2</sub>      d. alcohols
- The balanced equation for the complete combustion of nonane requires \_\_\_\_ moles of O<sub>2</sub> per mole of nonane.  
a. 18      b. 12      c. 16      **d. 14**
- The sp hybridization of carbon is required to explain the bonding of \_\_\_\_\_ in valence bond theory.  
a. benzene      **b. alkynes**      c. alkenes      d. cycloalkenes
- All of the following are isomers of C<sub>8</sub>H<sub>18</sub>; when burned fully, which gives off the **most** energy? **Answer b**



- What is the oxidation state of carbon in CHCl<sub>3</sub>?    a. +1    b. -1    c. -2    **d. +2**
- Which type of strain is still present in a chair-conformer cyclohexane?  
a. angle strain      b. torsional strain      **c. van der Waals strain**    d. bond length distortion
- Looking down the C2-C3 bond, which Newman projection is the most stable 2-methylbutane conformer? **d**



17. What is the main energy factor that makes an eclipsed conformer less stable than a similar staggered one?  
 a. bond length distortion    b. van der Waals strain    c. hydrogen bonding    **d. torsional strain**
18. The only truly planar cycloalkane is  
 a. cyclohexane    b. cyclobutane    c. cyclooctane    **d. cyclopropane**
19. Cyclopentane reduces its strains by taking one of two conformations: the envelope and the  
**a. half-chair**    b. twist chair    c. bent pentagon    d. full boat
20. The most stable conformer of *cis*-1,3-dimethylcyclohexane has the methyl groups  
**a. both equatorial**    b. both axial    c. axial and equatorial    d. staggered and gauche
21. All *spiro*-compounds contain \_\_\_\_\_ rings fused at \_\_\_\_\_ carbon atom(s).  
**a. 2 ; 1**    b. 2 ; 2    c. 2 ; 3    d. 3 ; 3
22. Which of the following has a bicyclo[3.2.1] ring system? **Answer b**

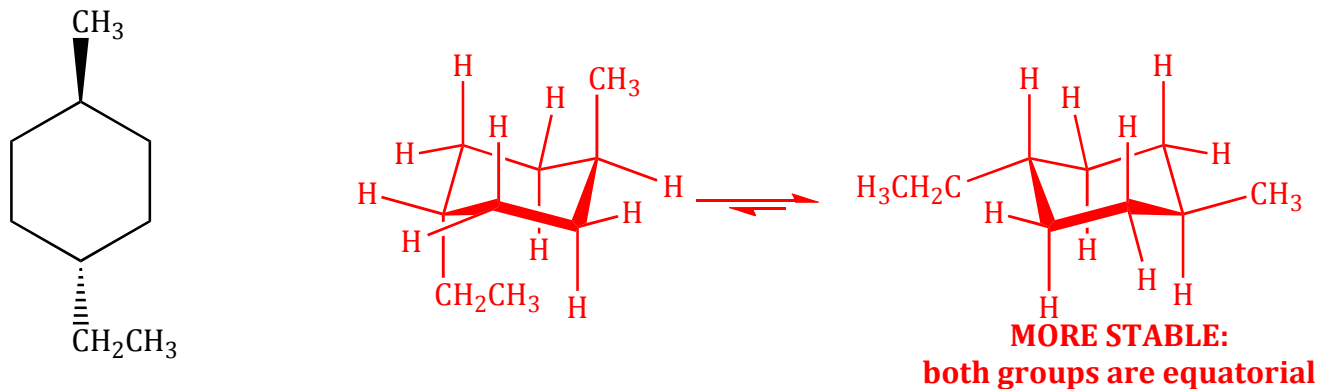


23. The proper IUPAC name for  $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{CH}_2\text{OH}$  would be  
 a. 4,4-dimethyl-1-butanol    **b. 4-methyl-1-pentanol**    c. 1,1-dimethyl-4-butanol    d. 3-isopropyl-1-propanol
24. Which reagent will be best to convert 2-butanol to 2-bromobutane?  
 a. NaBr    b.  $\text{CaBr}_2$     c.  $\text{Br}_2$  in  $\text{CCl}_4$     **d. HBr + heat**
25. What combination of reagents is used to identify whether an alcohol is 1°, 2, or 3°?  
 a.  $\text{KBr} + \text{H}_2\text{SO}_4$     **b.  $\text{ZnCl}_2 + \text{HCl}$**     c.  $\text{Na} + \text{F}_2$     d.  $\text{NaNH}_2 + \text{H}_2\text{O}$
26. Which alcohol is most likely to react with HBr in a reaction involving formation of a carbocation?  
 a. ethanol    **b. 2-methyl-2-butanol**    c. 2-butanol    d. methanol
27. Which of these alcohols is most likely to react only via an  $\text{S}_{\text{N}}2$  reaction mechanism?  
**a. ethanol**    b. 2-methyl-2-butanol    c. 2-butanol    d. 2-propanol
28. The **nucleophile** in the substitution reaction of 2-butanol with HCl is  
**a.  $\text{Cl}^-$  ion**    b.  $\text{H}_3\text{O}^+$  ion    c.  $\text{OH}^-$     d.  $\text{H}_2\text{O}$
29. A good alternative to HCl for the conversion of alcohols into alkyl chlorides is  
**a.  $\text{SOCl}_2$**     b. NaCl    c.  $\text{AlCl}_3$     d.  $\text{Cl}_2$
30. When you brominate 2-methylbutane using  $\text{Br}_2$ , the most common monobromination product should be  
 a. 1-bromo-3-methylbutane    b. 2-bromo-3-methylbutane  
 c. 1-bromo-2-methylbutane    **d. 2-bromo-2-methylbutane**

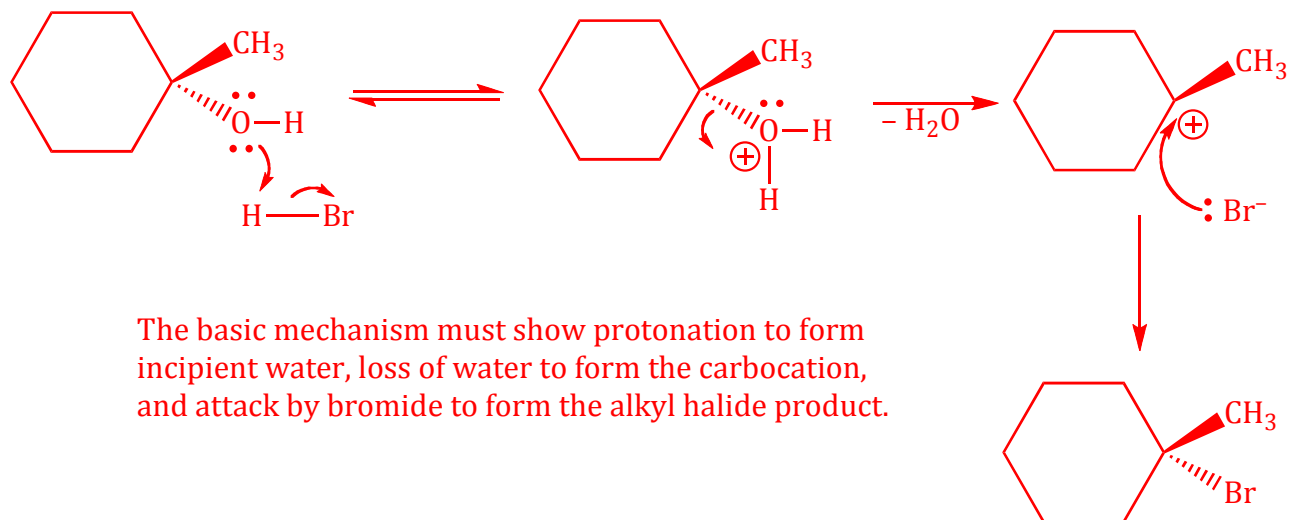
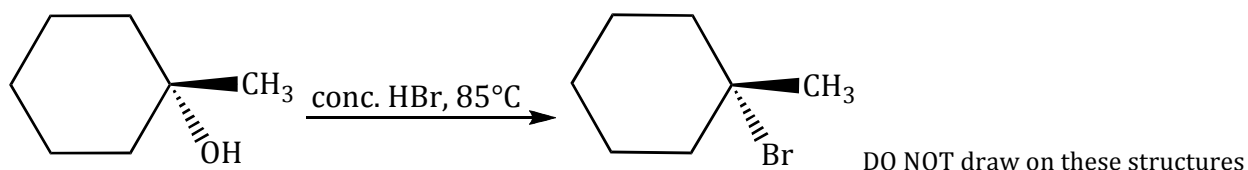
Problems on next page...

**Problems(40%; 20% each)****SHOW WORK** as requested for each problem:

- I. **Draw both chair conformations** of the compound shown below\*. Be sure that the axial and equatorial locations of each hydrogen and other substituent are clearly shown in their proper locations and state if one of the two chairs is more stable than the other, with a brief explanation of why.



- II. **GIVE THE STEPS** in the mechanism of the reaction shown below, which has been found to be an  $S_N1$  reaction under the conditions in which it is run. This means you need to show the structures of any intermediates and use 'curved arrows' to indicate electron movement in the steps of the mechanism.



\* Note that the structure drawn is NOT a chair conformation as drawn; it just gives the groups and that they are *trans*.