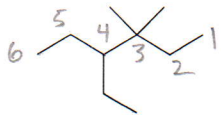
Key – Summer 2017
Midterm
3311

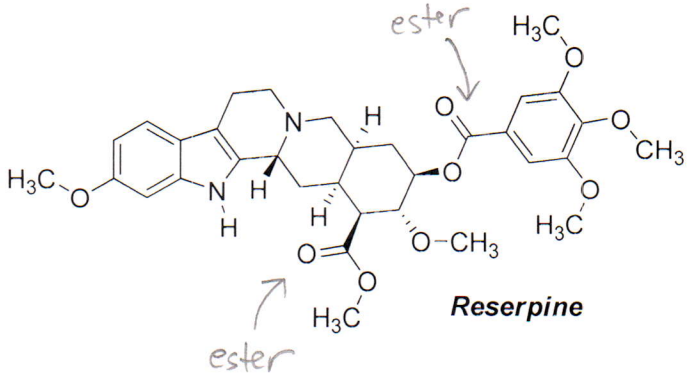
1. Select the correct name of this molecule.



B

a. 3-ethyl-4,4-dimethylhexane
b. 4-ethyl-3,3-dimethylhexane
c. 3,3-dimethyl-4-ethylhexane
d. 2-methyl-2,3-diethylpentane
e. 2,3-diethyl-2-methylpentane

2. Here is the structure of reserpine, a drug used for the treatment of high blood pressure and psychosis. (Lone pairs are omitted for simplicity.) Which carboxylic acid derivative is present in reserpine?



Reserpine

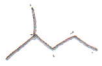
C

a. Acid halide
b. Anhydride
c. Ester
d. Amide
e. None of these groups are present in reserpine

3. In the structure of reserpine shown in #2, the lone pairs are not explicitly drawn, but all atoms are neutral. How many lone pairs of electrons are there on <u>each</u> nitrogen atom?

B

a. 0
b. 1
c. 2
d. 3
e. One billion

 C_6H_{14}

4. 2-Methylpentane is a member of a set of constitutional isomers. Which of these molecules is **not** a constitutional isomer of 2-methylpentane?

 C_6H_{14}

 C_6H_{14}

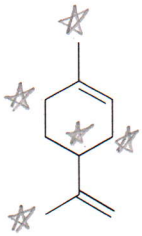
 C_6H_{14}

 C_6H_{14}

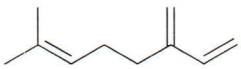
E

a. 3-methylpentane
b. 2,2-dimethylbutane
c. 2,3-dimethylbutane
d. hexane
(e.) All of these molecules are constitutional isomers of 2-methylpentane.

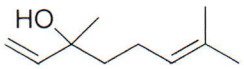
5. Orange oil, which you will isolate from orange peels in lab, is composed of a mixture of organic compounds. Here are three examples of the compounds found in orange oil:



Limonene



Myrcene



Linalool

Each of these compounds contains one or more carbon-carbon double bonds. What is the percentage of *p* character for the hybrid orbitals on a carbon involved in a double bond?

D

Those carbons are sp^2 hybridized; thus one part s, two parts p

a. 25%
b. 33.3%
c. 50%
(d.) 66.7%
e. 75%

6. Referring to the structures in question #5, how many allylic carbons are there in limonene?

Noted with ★

E

a. 1
b. 2
c. 3
d. 4
(e.) 5

7. What is the approximate pK_a value of linalool?

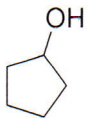
↓

It is an alcohol, so 15-18

B

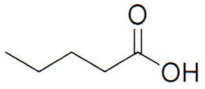
a. 5
(b.) 16
c. 36
d. Not enough information available

8. Arrange the three acids in order of **decreasing** pK_a. (Highest to lowest)



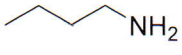
15-18

W



4-5

X



36

Y

C

a. W > X > Y
b. Y > X > W
c. Y > W > X
d. W > Y > X
e. X > Y > W

9. Using a conjugate base stability argument, which factor is the best explanation for the difference in acidity between structures **W and X** in question 8?

Conjugate base of X is stabilized by resonance, conjugate base of W is not

A

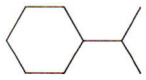
a. Resonance
b. Electronegativity
c. Charge effect
d. Size/Polarizability

10. Using a conjugate base stability argument, which factor is the best explanation for the difference in acidity between structures **W and Y** in question 8?

B

a. Hybridization
b. Electronegativity
c. Inductive effect
d. Size/Polarizability

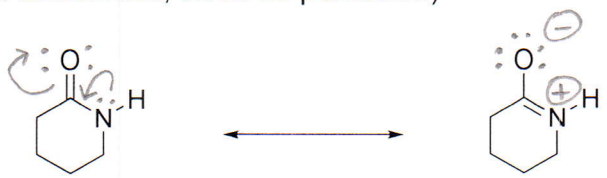
11. The common name for the group attached to this cyclohexane ring is



A

a. isopropyl
b. *sec*-butyl
c. *tert*-butyl
d. isobutyl
e. neobutyl

12. One of the functional groups we discussed in class was an amide. Amides can occur as cyclic structures called *lactams*. (Certain types of lactams are used as antibiotics, such as penicillin.)



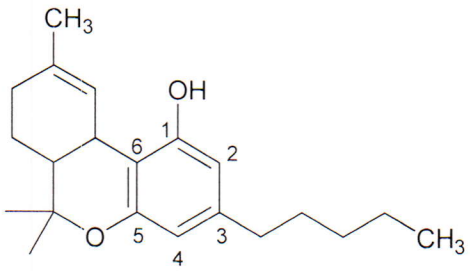
Major resonance contributor of a lactam ⟷ **Minor resonance contributor of a lactam**

A

In the structures above, lone pairs are not explicitly drawn and formal charges not calculated. In the major resonance contributor, all atoms are neutral. Which of the following correctly describes the formal charges in the minor resonance contributor shown above?

	Nitrogen	Carbonyl oxygen	Carbonyl carbon
A	+	–	0
B	–	+	0
C	0	–	+
D	0	+	–
E	None of the answer choices A-D is correct.		

13. Tetrahydrocannabinol (THC) is the major psychoactive component in cannabis. Some of the carbon atoms are numbered in the structure for reference. Lone pairs are not explicitly drawn, but all atoms are neutral.



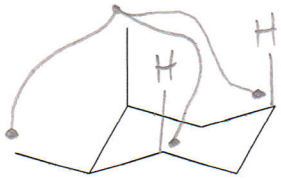
Tetrahydrocannabinol

D

According to valence bond theory, what orbitals are overlapping to form the π bond between C5 and C6?

a. *sp* and *sp*
b. sp^2 and sp^2
c. sp^3 and sp^3
d. *p* and *p*

14. How many gauche butane interactions are there in this structure?



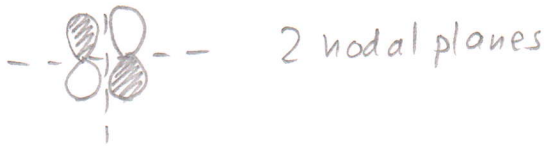
D

a. 0 (none)
b. 1
c. 2
d. 3
e. 4

15. A C-C π* represents an out of phase combination of two *p* orbitals. How many nodes are there in a C-C π* orbital?

C

a. 0
b. 1
c. 2
d. 3
e. One billion



16. There are several isomers of 1-isopropyl-3-methylcyclohexane. Chair conformations of some of them are shown here. Which of these chair conformations represents the lowest energy structure?

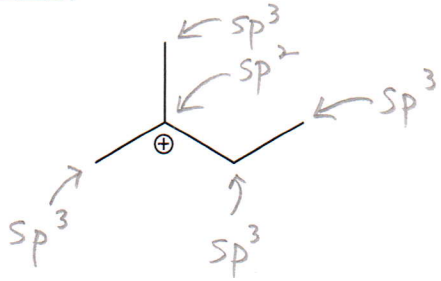
Both groups equatorial

A

A B C D All the structures have the same energy

17. How many unhybridized *p* orbitals are there in this structure?

B

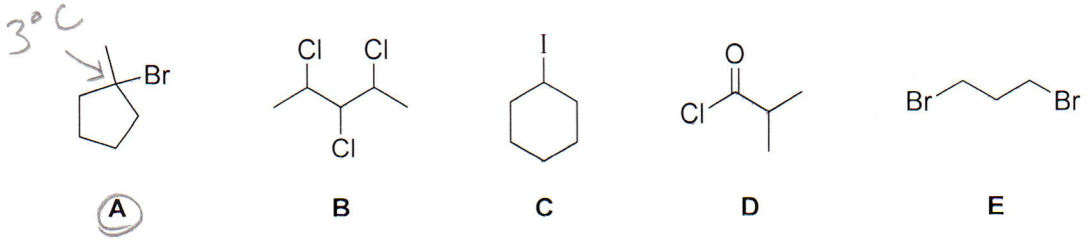


a. 0
b. 1
c. 2
d. 3
e. Some other number; e.g. one billion

All other carbons except for the one with the ⊕ are sp^3 hybrids and thus have no unhybridized p orbitals. The sp^2 C has one unhybridized p orbital remaining after "using" its basis set (s, p, p, p) to make three sp^2 orbitals.

18. Which of these structures is a tertiary alkyl halide?

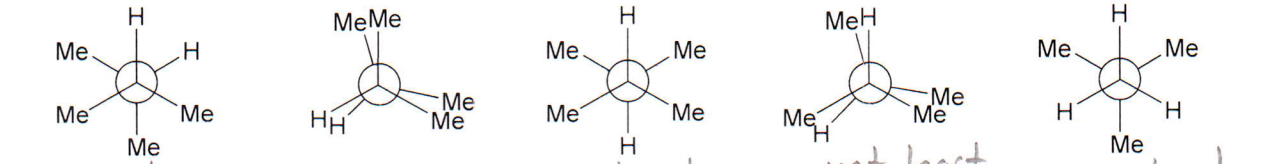
A



(A) B C D E

19. Which of these Newman projections shows the least stable conformation of 2,3-dimethylbutane looking down the C2-C3 bond?

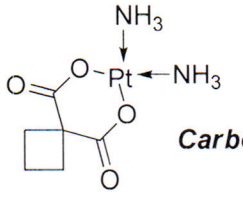
B



not least stable — not least stable — not least stable — not

A (B) C D E

20. In lecture, we discussed the types of strain present in cyclobutane. A compound based on cyclobutane is called carboplatin. Carboplatin is used to treat various types of cancer. (The ammonia molecules "coordinate" to the platinum atom, and this interaction is represented by arrows in the structure. However, you should just focus on the four-membered ring.) What types of strain do you expect to be present in carboplatin?

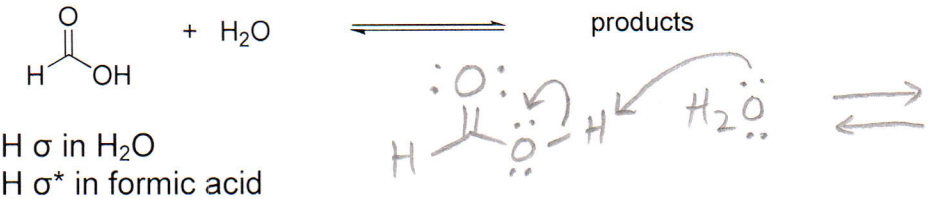


Carboplatin

E

- ✓ a. Torsional — cyclobutane cannot relieve all its torsional strain
- ✓ b. Steric — Groups other than H's eclipsing
- ✓ c. Angle
- d. Torsional and steric
- (e.) All three types of strain

21. Identify the LUMO in the reaction between formic acid and water.



B

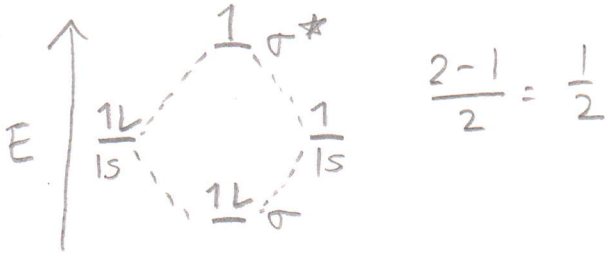
a. OH σ in H_2O
b. OH σ* in formic acid
c. sp^3 on O in H_2O
d. *s* in formic acid
e. nMO (nonbonding molecular orbital) in H_2O

22. A gauche butane interaction is

B

a. an example of torsional strain no - it's eclipsed conformations that have torsional strain
b. an example of steric strain
c. present only in butane not true
d. present only in acyclic molecules not true
e. described or defined by more than one of the choices a-d

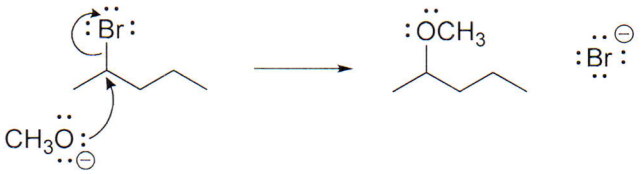
23. Calculate the bond order for the ion H_2^-.



B

a. 0
b. ½
c. 1
d. 1 ½
e. 2

24. Identify the HOMO in the reaction between methoxide ion, a nucleophile, and 2-bromopentane, an electrophile. Spectator ions are omitted from the mechanism for clarity.



D

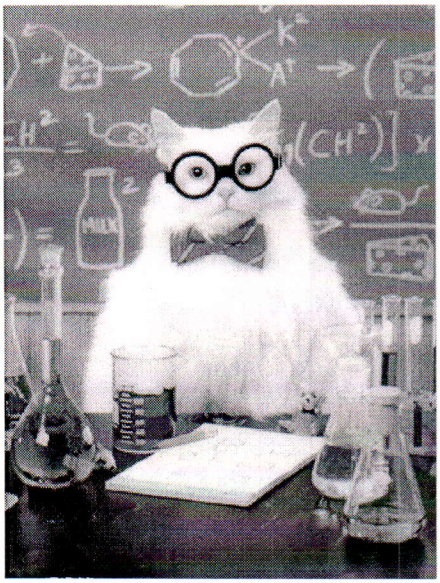
a. C-O σ
b. C-O σ*
c. C-Br σ*
d. nMO (nonbonding molecular orbital) in methoxide
e. nMO in 2-bromopentane

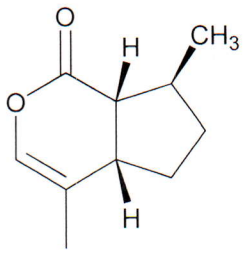
25. Recently at a concert, Justin Bieber was asked to sing the song "Despacito". This song is currently #1 on the Billboard Hot 100, and Bieber himself recorded it with two other musicians. According to the news report, when Bieber stated that he couldn't sing the song because he didn't know it, "...that didn't go over well as someone threw a bottle at him from the audience, which he ducked."

It is believed that someone placed a substance in Bieber's energy drink that resulted in his dramatic memory loss. The prime suspect is the Chemistry Cat, shown below. Authorities suspect that the Chemistry Cat secretly spiked Bieber's drink with a massive dose of nepetalactone, the active ingredient in catnip, and that Bieber had an unfavorable reaction to this compound.

Which statement best describes the hybridization of the oxygen atoms in nepetalactone? (Lone pairs are not explicitly drawn, but all atoms are neutral.)

A





nepetalactone

Recall the resonance argument

a. Both are sp^2 hybridized
b. Both are sp^3 hybridized
c. The carbonyl oxygen is sp^2 and the ester oxygen is sp^3
d. The carbonyl oxygen is sp^3 and the ester oxygen is sp^2