1. The correct names (either IUPAC or common) for each compound below are: **D**

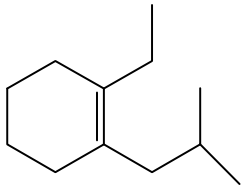
   a. I = 1-sec-butyl-2-ethylcyclohexene
      II = 3-vinyl-6-methyloctane
      III = 4-isopropyl-5,6-octene

   b. I = 1-isopropyl-6-ethylhexene
      II = 2,5-diethylhexene
      III = 6-methyl-5-propyl-3-heptene

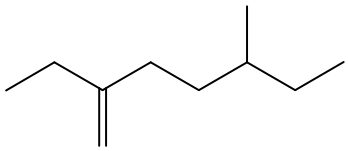
   c. I = 1-ethyl-6-isoamyl-6-cyclohexene
      II = 3-ethylene-6-ethyl-heptane
      III = 5-isobutyl-6-methyl-3-heptene

   d. I = 1-ethyl-2-isobutylcyclohexene
      II = 2-ethyl-5-methyl-1-heptene
      III = 5-isopropyl-3-octene

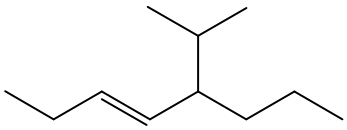
   e. none of these



I



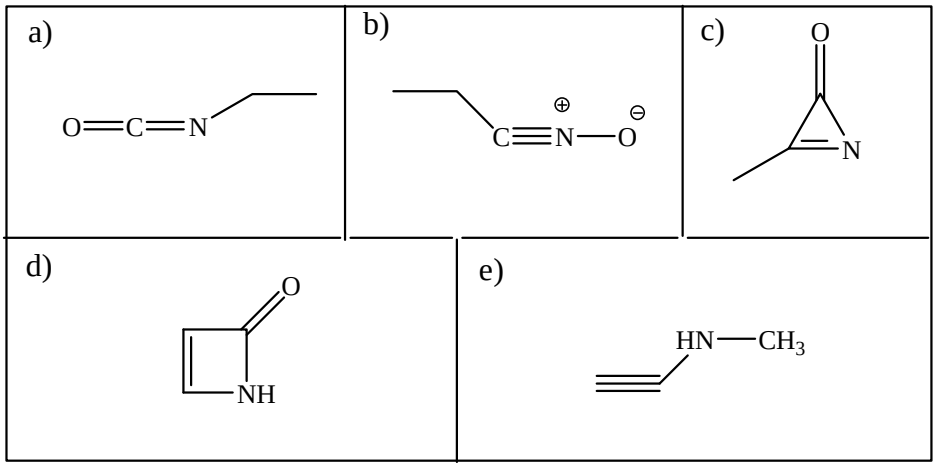
II



III

2. Which of the following is possible for structures with the molecular formula $C_7H_{17}NO$? **E**
   a. positional isomers
   b. functional group isomers
   c. skeletal isomers
   d. pi bonds and/or rings
   e. a & b

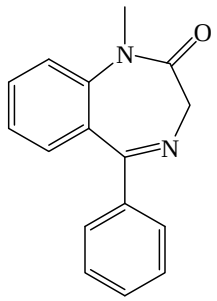
3. Ethyl isocyanate has a molecular formula of C_3H_5NO. It has two primary carbons. There is only one sp hybridized carbon and only one sp2 hybridized nitrogen. Which of the following structures represents ethyl isocyanate? **A**



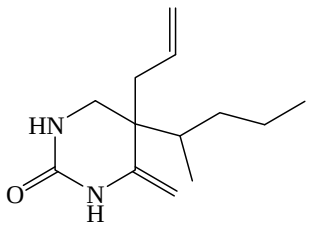
4. 4-tert-butylheptane contains: **E**
   a. five primary carbons
   b. one tertiary carbon
   c. four secondary carbons
   d. a & c
   e. a, b & c

5. Which of the following structures corresponds to a molecular formula of $C_{16}H_{14}N_2O$? **A**

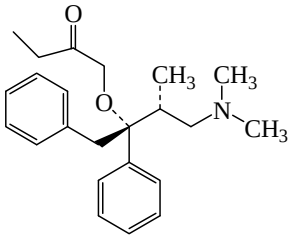
a)



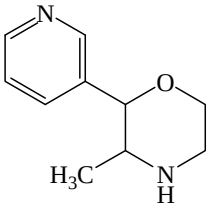
b)



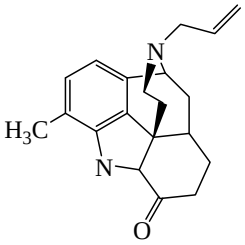
c)



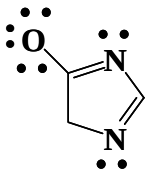
d)



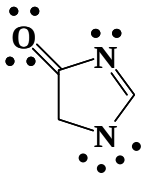
e)



6. Two isomeric structures are given below. Which of the following statements is true regarding these two structures? **E**



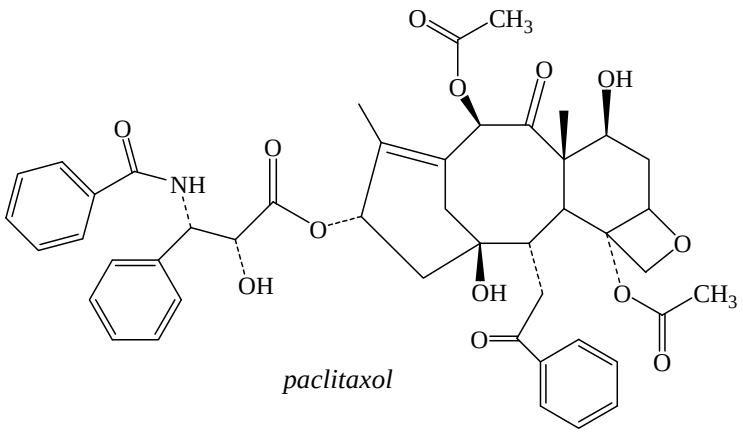
I



II

a) The oxygen atom has a formal charge in structure I but not in structure II
b) The oxygen atom has a formal charge in structure II but not in structure I
c) Both nitrogen atoms have a formal charge in structure I
d) Only one nitrogen atom in structure II has a formal charge
e) a & d

7. Paclitaxol is a drug used to treat cancer. Which of the following functional groups are present in the structure of paclitaxol? **B**

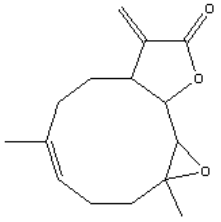


paclitaxol

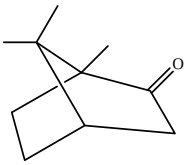
1. Primary amide
2. Secondary Amide
3. Tertiary amide
4. Primary alcohol
5. Secondary alcohol
6. Tertiary alcohol
7. Secondary amine
8. Tertiary amine
9. Ester
10. Ether
11. Ketone
12. Aldehvde

a. 3, 4, 11, 10, 6, 9
b. 2, 5, 9, 6, 10, 11
c. 1, 5, 11, 9, 10, 12
d. 11, 8, 5, 6, 9, 7
e. None of these

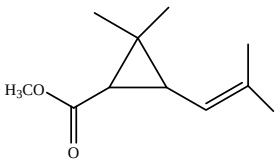
8. The three compounds below are constitutents of the natural herbal product, feverfew that has been reported to be effective in treating migraine headaches. These compounds can be separated using column chromatography. The retention times (rt) for each compound (determined experimentally) when separated using silica gel as the stationary phase and ethyl acetate: hexane (60:40) as the mobile phase are given below. Match each rt with the appropriate compound. **C**



A



B



C

1. rt = 12.25 minutes
2. rt = 15.66 minutes
3. rt 18.69 minutes

a. A = 12.25minutes
B = 15.66 minutes
C = 18.69 minutes

b. A = 18.69 minutes
B = 15.66 minutes
C = 12.25 minutes

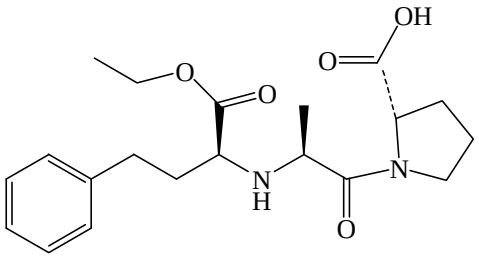
c. A = 18.69 minutes
B = 12.25 minutes
C = 15.66 minutes

d. A = 15.66 minutes
B = 12.25 minutes
C = 18.69 minutes

e. A = 15.66 minutes
B = 18.69 minutes
C = 12.25 minutes

9. The degree of unsaturation of oxyphenacetin with a molecular formula of $C_{24}H_{19}NO_5$ is: **D**
   a. 13
   b. 14
   c. 15
   d. 16
   e. 17

10. Which of the following non-covalent interactions are possible for enalapril, an antihypertensive agent? **A**

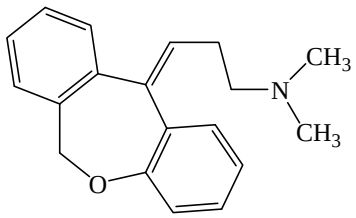


Enalapril
(antihypertensive)

1. Intramolecular H-bond
2. Intermolecular H-bond
3. Intramolecular dipole-dipole
4. Intermolecular dipole-dipole
5. Intramolecular Ion-Dipole
6. Intermolecular Ion-Dipole
7. Intramolecular Hydrophobic
8. Intermolecular hydrophobic

   a. 1, 2, 3, 4, 8
   b. 1, 2, 5, 6, 8
   c. 3, 4, 7, 8
   d. 2, 4, 6, 8
   e. 1, 2, 4, 7, 8

11. The substitution of the alkene in olopatadine is: **D**

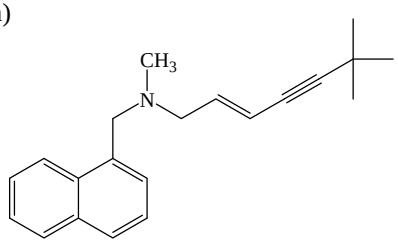


Olopatadine
(Patanol)

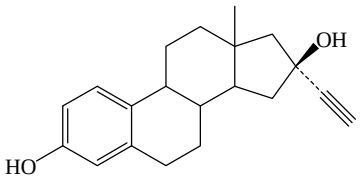
   a. tetrasubstituted
   b. monosubstituted
   c. disubstituted
   d. trisubstituted
   e. a, c, d

12. Which of the following molecules contains a terminal alkyne? **B**

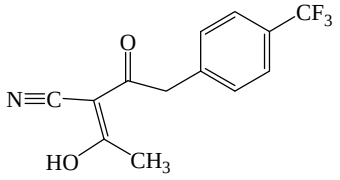
a)



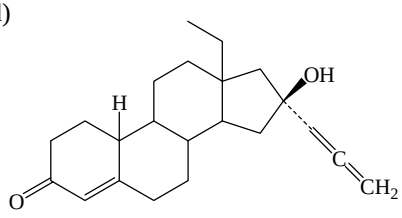
b)



c)



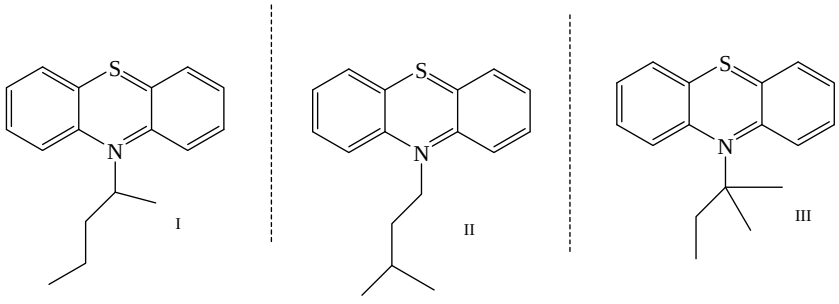
d)



e) b & c

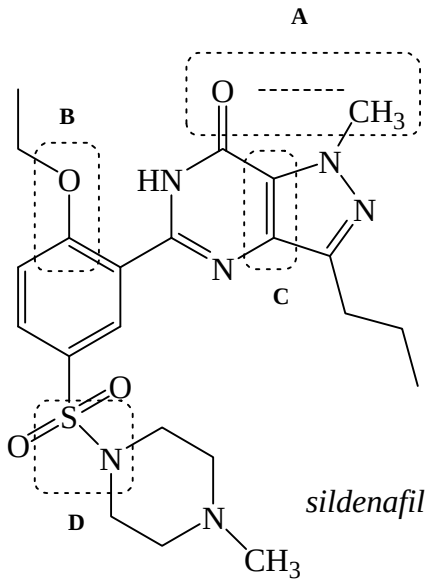
13. The valence *orbital(s)* associated boron is (are): **C**
    a. 2s orbital only
    b. 2p orbital(s) only
    c. 2s and 2p orbitals only
    d. 2s, 2p and 3s orbitals
    e. sp2 orbitals

14. Minor modifications in drug structure often give rise to different biological activity as illustrated by the three compounds below. Which of the follow best describes the *differences* among these three compounds? **B**



    a. I contains a secondary amine, II contains a primary amine and III contains a tertiary amine
    b. I contains a neopentyl group, II contains an isoamyl group and III contains a tert-amyl group
    c. The N is sp3 hybridized in I and sp2 hybridized in II and III
    d. I contains a sec-butyl, II contains an isobutyl and III contains a tert-butyl group
    e. a & b

15. Characterize the highlighted bonds as polar covalent, non-polar covalent, ionic or non-covalent in the structure of sildenafil below. **D**



sildenafil

a. A = polar covalent
   B = polar covalent
   C = non-polar covalent
   D = ionic

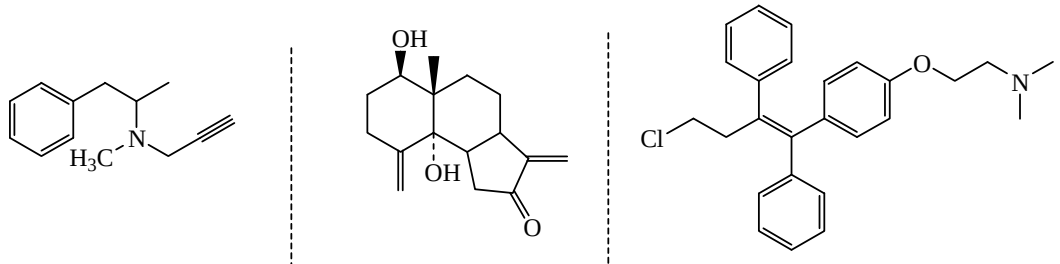
b. A = non-covalent
   B = polar covalent
   C = non-polar covalent
   D = ionic

c. A = non-covalent
   B = polar covalent
   C = polar covalent
   D = non-polar covalent

d. A = non-covalent
   B = polar covalent
   C = non-polar covalent
   D = polar covalent

e. A, B, C, D are all polar covalent

16. Each of the compounds below would give rise to an absorbance in the UV-VIS region of the electromagnetic spectrum at a specific λ_{max}. Rank the three compounds and their λ_{max} values from *longest wavelength to shortest wavelength* (longest >> shortest). **C**

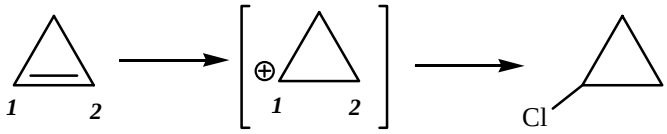


I II III

Since this question was not thoroughly covered in lab or background reading all students received credit for this question. But C is in fact the correct answer.

a. I > II > III
b. III > II > I
c. III > I > II
d. II > I > III
e. II > III > I

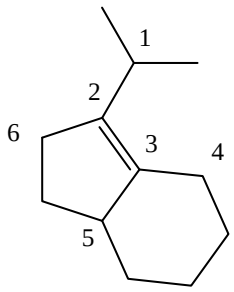
17. Reaction of cyclopropene with hydrochloric acid occurs in a two step process to give chlorocyclopropane as the final product of the reaction. In the first step of the reaction, cyclopropene reacts with the hydrogen of HCl to give a cyclopropyl carbocation. The carbocation reacts with the chloride ion (Cl-) in the second step to give the product. Which of the following statements related to this reaction are true?
No correct answer provided. All students received credit.



a. The hybridization of C_1 changes from sp2 hybridized to sp3 hybridized in step 1 of this reaction.
b. The pi bond of cyclopropene is formed by overlap of an sp2 orbital of C_1 and an sp2 orbital of C_2.
c. The C_2 carbon of the carbocation has trigonal planar geometry.
d. The degree of unsaturation of the product is greater than the degree of unsaturation in the starting material.
e. a & c

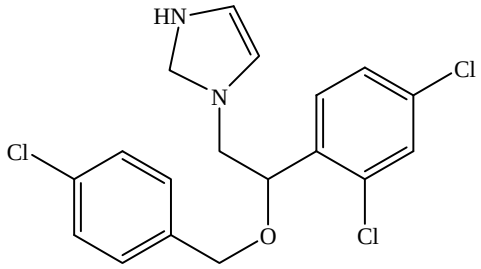
18. For which of the following alkenes are cis/trans steroisomers possible? **D**
a. 1-pentene
b. 2-methyl-2-pentene
c. 3-ethyl-2-pentene
d. 2-pentene
e. all of these

19. Which atoms labeled in the structure below are in the same plane? **D**



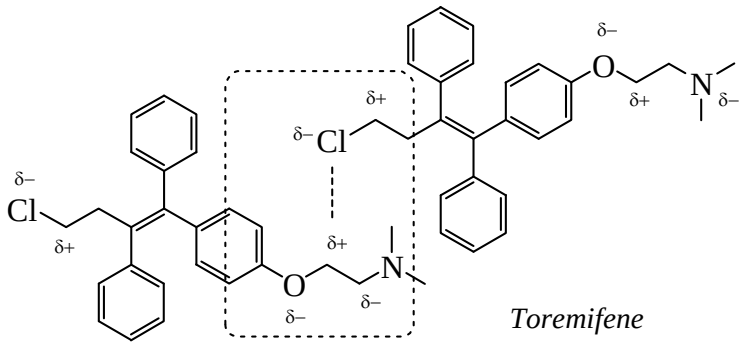
a. 2, 3
b. 1, 2, 3, 4
c. 2, 6, 3, 4
d. 1, 2, 3, 4, 5, 6
e. 1, 6, 4, 5

20. How many polar covalent bonds are present in the molecule below? **C**



a. 9
b. 10
c. 11
d. 12
e. 13

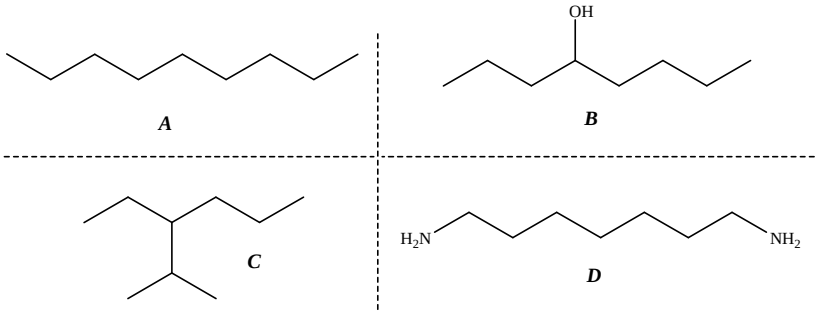
21. The interaction highlighted in the box below is an example of: **B**



Toremifene

a. intramolecular ion-dipole
b. intermolecular dipole-dipole
c. intramolecular dipole-dipole
d. intermolecular hydrophobic
e. intermolecular ion-dipole

22. The structures of four compounds are provided below on the left, and the boiling points of these four compounds are provided on the right. Match each structure to its boiling point. **E**



Boiling Points
225-226°C
176°C
150°C
138°C

a. A = 225-226°C
B = 150°C
C = 138°C
D = 176°C

b. A = 138°C
B = 176°C
C = 150°C
D = 225-226°C

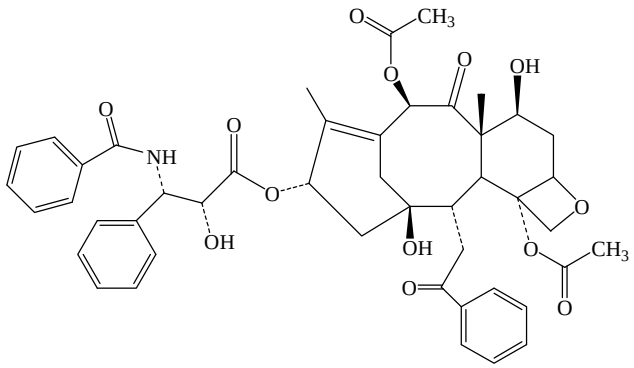
c. A = 176°C
B = 150°C
C = 138°C
D = 225-226°C

d. A = 150°C
B = 138°C
C = 176°C
D = 225-226°C

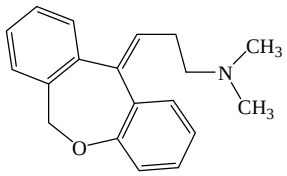
e. A = 150°C
B = 176°C
C = 138°C
D = 225-226°C

23. Which of the molecules below contains *only* three allylic carbon atoms? **D**

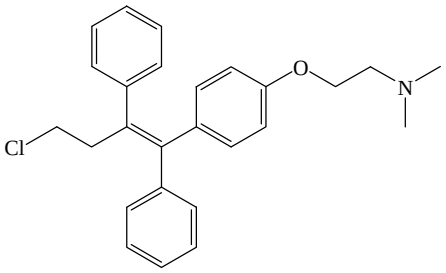
a)



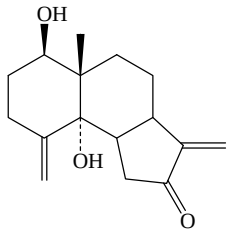
b)



c)

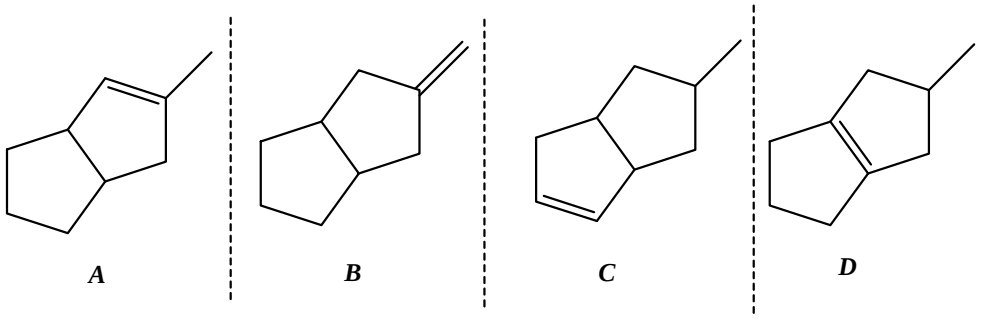


d)



e) b & d

24. Rank the alkenes below from most stable to least stable (most>>least) **D**



A ***B*** ***C*** ***D***

a. A > B > C > D
b. D > C > B > A
c. A > B = C > D
d. D > A > B = C
e. D > A > C > B

25. β-Carotene has a molecular formula of $C_{40}H_{56}$. It contains two rings and no triple bonds. How many double bonds does it have? **D**

a. 14
b. 13
c. 12
d. 11
e. 10