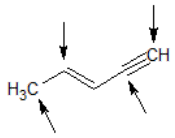
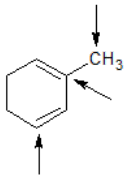
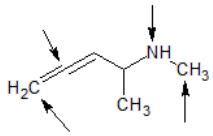
2.16: ADDITIONAL EXERCISES

HYBRIDIZATION

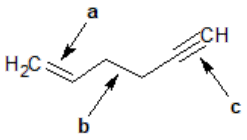
2-1 For each of the following compounds, identify the hybridization of each carbon or nitrogen atom with an arrow pointed at it.

(a) 

(b) 

(c) 

2-2 Rank the following bonds in order of decreasing bond length. Then rank the bonds in order from strongest to weakest.



2-3 How many sigma and pi bonds are in a molecule of ethane (C_2H_6)?

2-4 How many sigma and pi bonds are in a molecule of ethylene (C_2H_4)?

2-5 How many sigma and pi bonds are in a molecule of acetylene (C_2H_2)?

HYBRIDIZATION, ELECTRON GEOMETRY, AND MOLECULAR SHAPE

2-6 What is the hybridization state and geometry of the carbon atom in methane (CH_4)?

a) *sp*, linear

b) sp^3, tetrahedral

c) sp^2, trigonal planar

d) None of the above

2-7 Identify the electron geometry of the following compounds.

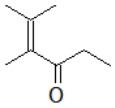
a) H_2O

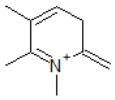
b) PF_5

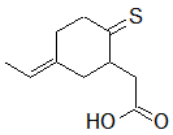
c) NH_4^+

d) The carbonyl carbon of acetone $(CH_3)_2CO$. (Note that double bonds between carbon and oxygen must be recognized.)

2-8 For the following compounds, identify which atoms have sp^2 hybridization.

(a) 

(b) 

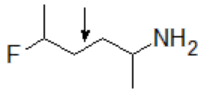
(c) 

2-9 Draw the orbitals showing the geometric shape of ammonia (NH_3). Identify its geometric shape.

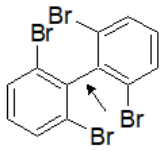
2-10 What is the geometric shape of the boron atom in BH_3? What is the bond angle of the hydrogen atoms?

BOND ROTATION

2-11 Will the following compound experience free rotation around the middle bond? Explain why or why not.



2-12 Will the following compound experience free rotation around the middle bond? Explain why or why not.



2-13 Can a molecule of ethylene experience free rotation around the C=C bond?

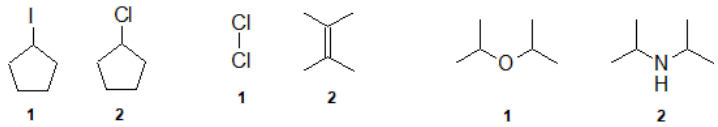
POLARITY OF BONDS AND MOLECULES

2-14 For the following compounds, draw an arrow to show the direction of the dipole moment (if any).

(a) (b) (c) (d)

2-15 In the following pairs of compounds, identify the compound with the larger dipole moment (if any).

(a) (b) (c)

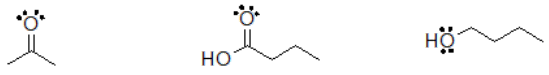


2-16 True or False: Generally, the larger the difference in electronegativity of connected atoms, the greater the dipole moment.

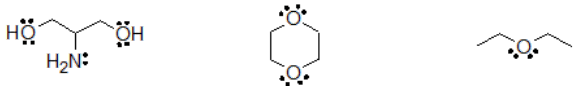
INTERMOLECULAR FORCES (IMFS)

2-17 Identify which of the following compounds can form hydrogen bonds.

(a) (b) (c)



(d) (e) (f)



2-18 For the compounds in the previous problem (**2-17 above**) that can hydrogen bond, draw how they can form those bonds.

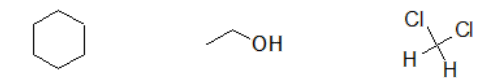
2-19 Identify what type of intermolecular force the following compounds experience.

(a) (b) (c) (d)

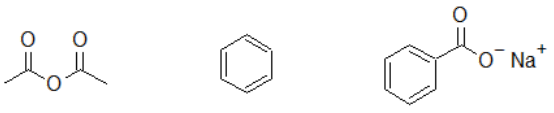
IMFS AND SOLUBILITY

2-20 Identify whether the following compounds are miscible or soluble in water.

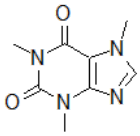
(a) (b) (c)



(d) (e) (f)



2-21 Identify which solvent, hexanes or dichloromethane (DCM), would be the better solvent to dissolve 3.0 grams of caffeine. Explain your answer.



Caffeine

HYDROCARBONS AND AN INTRODUCTION TO ISOMERISM

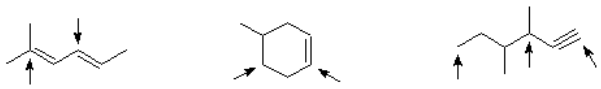
2-22 Identify whether the following hydrocarbons are alkanes, alkenes, or alkynes.

(a) (b) (c)

(d) (e) (f)

2-23 For the following compounds, identify the hybridization state of each labeled carbon.

(a) (b) (c)



2-24 Draw all possible isomers for the following compounds.

a) C_4H_{10}

b) C_6H_{14}

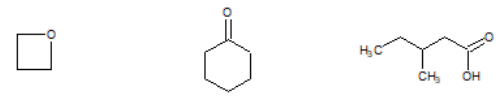
c) C_3H_6

2-25 Does $(CH_3)_2CHCCCH_3$ show cis/trans isomerism? Explain why or why not.

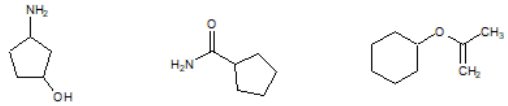
ORGANIC COMPOUNDS WITH OXYGEN

2-26 Identify the functional group(s) of each compound.

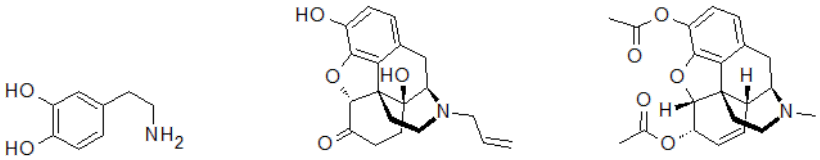
(a) (b) (c)



(d) (e) (f)



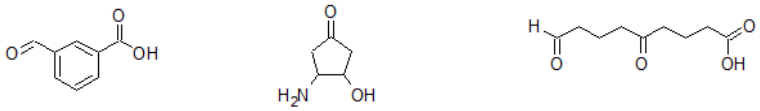
2-27 What functional groups are found in the following compounds?



Dopamine Naloxone Heroin

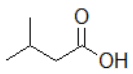
2-28 What oxygen-containing functional groups are present in the following compounds. The nitrogen-containing group is a challenge question.

(a) (b) (c)

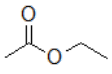


2-29 Identify whether the functional groups on the following compounds are classified correctly. If not, give the correct classification.

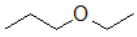
(a) (b) (c)



- ketone
-alcohol



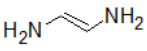
- ether
- ketone



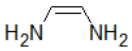
- ether

ORGANIC COMPOUNDS WITH NITROGEN

2-30 First, identify which of the following compounds has a dipole moment. Then, predict which of the following compounds will have the higher boiling point and explain why.



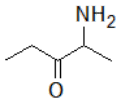
a



b

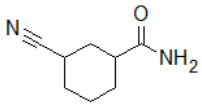
2-31 Identify whether the functional groups of the following compounds are classified correctly. If not, give the correct classification.

(a) (b) (c)



- amide

- cyanoamine



- ketone
- amine
- nitrile

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