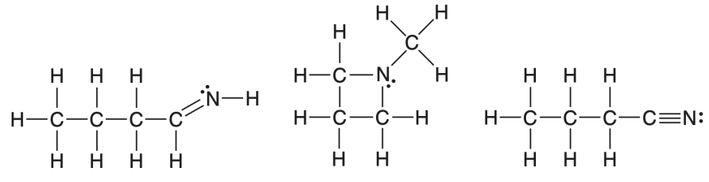
Organic Chemistry

Final Exam

(Time Allowed: 120 min)

1. Consider the three compounds shown below and then answer the questions that follow:



Compound A

Compound B

Compound C

(a) Which two compounds are constitutional isomers? _____

(b) Which compound contains a nitrogen atom with trigonal pyramidal geometry? _____

(c) Identify the compound with the greatest number of σ bonds. _____

(d) Identify the compound with the fewest number of σ bonds. _____

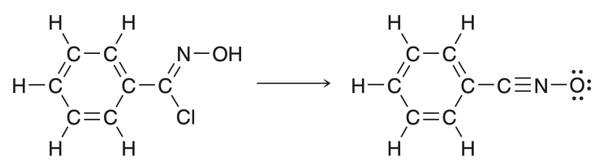
(e) Which compound contains more than one π bond? _____

(f) Which compound contains an sp^2-hybridized carbon atom? _____

(g) Which compound contains only sp^3-hybridized atoms (in addition to hydrogen atoms)? _____

(h) Which compound do you predict will have the highest boiling point? Explain.

2. The formation of a variety of compounds called oxazolidinones is important for the synthesis of many different natural products and other compounds that have potential use as future medicines. One method for preparing oxazolidinones involves the conversion of a hydroximoyl chloride, such as compound **1**, into a nitrile oxide, such as compound **2**:



1

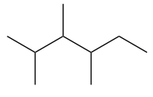
2

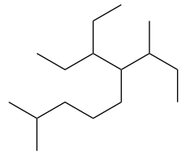
(a) Identify any formal charges that are missing from the structures of **1** and **2**.

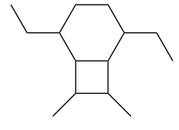
(b) Determine which compound is expected to be more soluble in a polar solvent, and justify your choice.

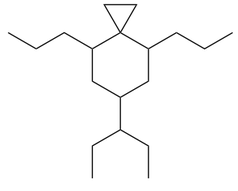
(c) Determine the amount by which the C–C–N bond angle increases as a result of the conversion from **1** to **2**.

3. Provide a systematic name for each of the following compounds:

(a) 

(b) 

(c) 

(d) 

(a) _____

(b) _____

(c) _____

(d) _____

4. Draw a skeletal formula for the following compounds:

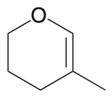
(a) 3-ethyl-2,5-dimethylhexane

(b) 3,4-diethylhexane

(c) 3,4-diisopropylbicyclo[4.1.0]heptane

(d) spiro[3.4]octane

5. Draw resonance structures for each of the following:

(a) 

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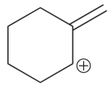
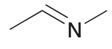
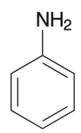
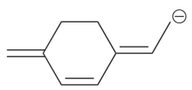
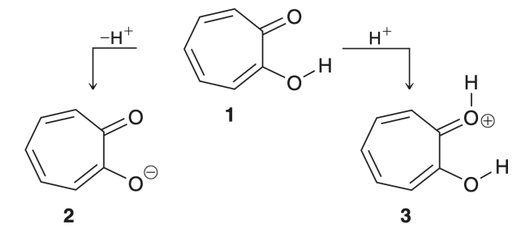
(c) 

(d) 

(e) 

(f) 

6. Tropolone **(1)** is a compound that is both fairly acidic and fairly basic. It is acidic because it is capable of losing a proton (H^+) to form a relatively stable anion **(2)**, while it is basic because of its ability to receive a proton to form cation **3**:



(a) Draw all significant resonance structures of anion **2** and of cation **3** and explain why each of these ions is stabilized.

(b) In compound **1**, the bond lengths for the C–C bonds vary greatly and alternate in length (long, short, long, etc.). But in ions **2** and **3**, the lengths of the bonds are similar. Explain.

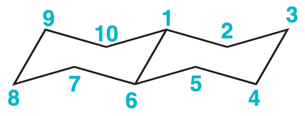
(c) The intramolecular hydrogen bonding interaction in **3** is significantly diminished in comparison to **1**. Explain.

7. Use a Newman projection, about the indicated bond, to draw the most stable conformer for each compound.

(a) 3-methylpentane about the C2−C3 bond

(b) 3,3-dimethylhexane about the C3−C4 bond

8. Below is the numbered skeleton of trans-decalin:



Identify whether each of the following substituents would be in an equatorial (**E**) position or an axial (**A**) position:

(a) A group at the C-2 position, pointing UP _____

(b) A group at the C-3 position, pointing DOWN _____

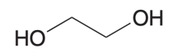
(c) A group at the C-4 position, pointing DOWN _____

(d) A group at the C-7 position, pointing DOWN _____

(e) A group at the C-8 position, pointing UP _____

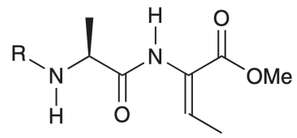
(f) A group at the C-9 position, pointing UP _____

9. Compare the three staggered conformations of ethylene glycol. The *anti* conformation of ethylene glycol is not the lowest energy conformation. The other two staggered conformations are actually lower in energy than the *anti* conformation. Suggest an explanation.



Ethylene glycol

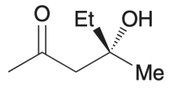
10. Bogorol A is a natural product with the potential to fight antibiotic-resistant bacteria. Shown below is an intermediate that was used in a synthesis of bogorol A. Shown below is an intermediate that was used in a synthesis of bogorol A. figuration of the alkene unit as either *E* or *Z*.



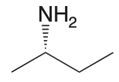
Intermediate in synthesis of bogorol A

Configuration: _____

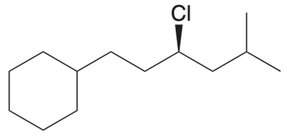
11. Identify the configuration of each chiral center in the following compounds. If there are more than one chiral centers, use numbers or letters to label each of them.

(a) 

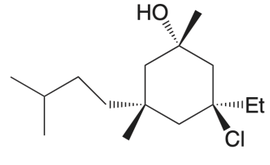
Configuration(s): _____

(b) 

Configuration(s): _____

(c) 

Configuration(s): _____

(d) 

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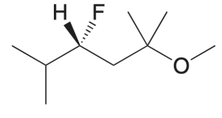
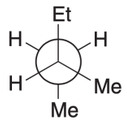
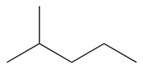
(e) 

Configuration(s): _____

12. For each of the following pairs of compounds, determine the relationship between the two compounds:

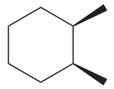
(a)





Relationship:_____

(b)

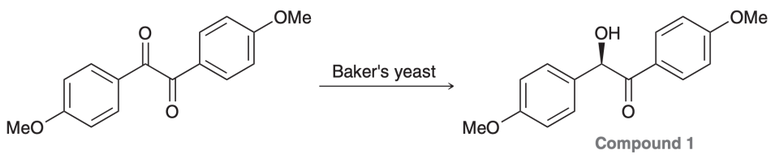


Relationship:_____

13. When 0.095 g of cholesterol is dissolved in 1.00 mL of ether and placed in a sample cell 10.0 cm in length, the observed rotation at 20°C (using the D line of sodium) is −2.99°. Calculate the specific rotation of cholesterol.

14. The specific rotation of vitamin B_7 in water (at 22°C) is +92. A chemist prepared a mixture of vitamin B_7 and its enantiomer, and this mixture had a specific rotation of +85. Calculate the % *ee* of this mixture.

15. Synthetic chemists often employ enzymes to conduct asymmetric syntheses that favor the production of one enantiomer over another. Baker's yeast was used to convert the diketone shown into alcohol **1**, with an *ee* of 84%. The specific rotation for the pure (*S*) enantiomer of **1** is reported to be +88.6. Calculate the observed specific rotation, [α], for the sample of 1 that was synthesized with baker's yeast. (Tips: be careful with the sign of [α]!)



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