CHEM 210 Exam 2 Practice Test – Solutions

1C
Given that the left-most carbon is numbered 1, the second and third carbons are the only chiral centers.
The second carbon has its hydrogen going into the page, and so we do not need to alter the orientation of the molecule to get the right configuration. Looking at the priorities, the rotation is clockwise, so it has R-configuration (2R).
The third carbon also has its hydrogen going into the page, and thus doesn't need to be reoriented. Looking at the priorities, the rotation is counter-clockwise, so it has S-configuration (3S).

2D
The double bond on the left side of the molecule shown assigns greatest priority to the CN bonds, as they are equivalent to three C-N bonds. Thus the left double bond has its top priority groups on opposite sides, and is E configuration.
The double bond on the right side of the molecule shown assigns greatest priority to the COOH group on the upper-right side, and the complex group on the lower-left side (this pathway gets us to the CN bond quicker than taking the upper-left pathway. Thus the right double bond has its top priority groups on opposite sides, and is E configuration.

3D
The most reliable way to determine the similarities between the compounds is to consider the configuration around each chiral center for each of the compounds.

Left Compound:
Going from left to right the configurations are R, and R.

Right Compound:
Going from left to right the configurations are R (after rotating bond so that the methyl group is behind), and S.

Aside from their configurations, the compounds are identical, and so we classify them as diastereomers.

(Remember that if they had entirely opposite configurations, RR and SS, then we would have enantiomers)

4A

Remember that a chiral center requires carbon to be attached to four different groups (hydrogens included though not shown). This only occurs six times in total throughout the molecule.

5D

The correct numbering of the carbon chain goes from right to left, such that the double bonds start on carbons 2 and 4.
The first double bond has its highest priority groups on the same side of the double bond, making it 2Z.
The second double bond also has its highest priority groups on the same side of the double bond, making it 4Z.

Thus the correct answer is D as it assigns the correct configuration and the correct carbon number for your chloride and isopropyl groups.

6D

Let's analyze the chirality of each option:

I. The C=C=C bon sequence will always be chiral if the groups attached on either end are different from each other. Thus we have a chiral molecule.
II. The only potential chiral center is not actually a chiral center since the two highest priority groups are actually identical (both are $CH(CH_3)_2$).
III. Since the ring structure is trans, you can assume there will be no plane of symmetry and the two chiral centers will not cancel out. This is therefore a chiral molecule.
IV. The molecule has a direct line of symmetry that splits the double bond in half, making it a meso structure (non-chiral molecule).
V. Here the two highest priority groups on the potentially chiral center are actually identical, and so the molecule does not have a chiral center.
VI. Here we have a chiral center with no planes symmetry. Thus we have a chiral molecule.

7D

Remember that every ring and/or double bond counts as one degree of unsaturation, and every triple bond counts as two. (Note that the benzene ring with the circle in the middle constitutes the equivalent of three double bonds)

Thus we have in total:	3 rings (3 degrees)
	6 double bonds (6 degrees)
	1 triple bond (2 degrees)
TOTAL:	11 degrees of unsaturation

8B
Since every option is identical in every way except configuration, we should look at the configuration of each:

(a) S-config
(b) R-config
(c) S-config
(d) S-config
(e) S-config

Thus B is the only structure that isn't identical to the others.

9D
When two radicals come together and cancel out in the products it's known as a termination step (usually step 3).

10
Since we know we're dealing with a 5-carbon chain with a methyl group on the middle carbon, we can place our chloride group on one of four unique locations:

1. On the middle carbon, C3
2. On the methyl group attached to the middle carbon.
3. On the second carbon, C2
4. On the first carbon, C1

All other placements are identical constitutional isomers.

11iC, 11iiB, 11iiiA

iC. Although the molecules look to be non-superimposable mirror images with chiral centers, they are in fact identical molecules. This is because the apparent chiral center in each case is actually not chiral since it has two identical methyl groups attached to the carbon.

iiB. They may appear to be mirror images, except that the configuration around the double bond is Z on the left molecule, and E on the right.

iiiA. By rotating the right molecule 180° about the plane of the page, you will see a direct mirror image of the left molecule.

12D
Only chiral molecules with a direct line of symmetry can be meso compounds.

A: A line of symmetry along the horizontal axis provides two identical halves, making it meso.
B: A line of symmetry along the horizontal axis would not lead to identical halves as the chlorines would be pointing up on one side and down on the other.
C: Rotating the structure 60° so that it has the eclipsed configuration, shows each group eclipsed by an identical group. This suggests it is a meso compound.
D: Since the methyl groups are trans configuration, there is no line of symmetry possible.

13B
Here we have a triangular 3-carbon-ring, with two bromides attached arbitrarily. In order for a line of symmetry to exist (while maintaining two chiral centers), the bromides need to be attached to separate carbons. When they are attached in the cis configuration, there is symmetry, and so we get one meso structure. When they are attached in the trans configuration there is no symmetry. Thus there is only one meso compound possible.

14D (NOT ON TEST)
For each answer choice we must consider the energy involved in forming the new bonds and breaking the old ones. Whichever answer choice is the most exothermic, is also the most stable, and thus most likely to proceed.

	<u>Bond broken</u>	-	<u>Bond Formed</u>	=	<u>ΔH</u>
A	CH_3 - H (104)	-	benzyl - H (112)	=	-8 kcal/mol
B	CH_3 - H (104)	-	benzyl - CH_2Cl (70)	=	+34 kcal/mol
C	CH_3 – Cl (84)	-	benzyl – Cl (97)	=	-13 kcal/mol
D	CH_3 – Cl (84)	-	benzyl – CH_3 (102)	=	-18 kcal/mol

15C

In this particular energy diagram, there is only one intermediate, C.
B and D represent transition states, while A and E represent the reactant and product, repectively.