1. Draw all possible isomers for….
   
   a. 2,3-dichlorobutane

   ![2,3-dichlorobutane structures](image)

   The (2R, 3S) is a meso compound which means that it is identical to the (2S,3R) compound, so there are only 3 possible isomers.

   b. 2-bromo-3-chlorobutane

   ![2-bromo-3-chlorobutane structures](image)

   Since the two stereocenters are NOT attached to the same groups (Br is not the same as Cl) there is NO plane of symmetry in the erythro enantiomers and they are not a meso compound, so there are 4 possible isomers.

   c. 2,4-dibromopentane

   ![2,4-dibromopentane structures](image)
The (2R, 4S) is a meso compound which means that it is identical to the (2S, 4R) compound, so there are only 3 possible isomers.

d. 1,3-dichlorocyclopentane

The (1R, 3S) is a meso compound which means that it is identical to the (1S, 3R) compound, so there are only 3 possible isomers.

e. 1,4-dimethylcyclohexane

No asymmetric C/s stereo centers (both sides of the ring are the same), so can’t use R, S nomenclature. Look for other possible isomers – here geometric/cis-trans isomers.

2. Name each of the following using R,S or E,Z designations where necessary. (Similar to Ch 5 #61)
E b/c more than 2 different groups/substituents on the double bond and highest priority groups (based on atomic number) are opposite each other across the double bond. [cis-trans more appropriate for compounds w/ only alkyl groups]

c. 3-chloro-pentan-2-ol can be redrawn as (2R,3R)-3-chloro-pentan-2-ol

d. 1,2-dibromo-2-methyl-pentan-3-ol (2S,3S)-1,2-dibromo-2-methyl-pentan-3-ol

e. 2-methyl-pentane-1,2,5-triol but group 4 is neither in front or in back, so rotate so the methyl is back (2R)-2-methyl-pentane-1,2,5-triol

f. 5-(2-chloroethyl)-2,4-dimethylnon-4-ene (4E)-5-(2-chloroethyl)-2,4-dimethylnon-4-ene

Additional Information:
Types of Isomers – See Isomers Summary Table

Chiral vs. Achiral
Chiral means handed – chiral molecules rotate plane polarized light
Enantiomer – non-superimposable mirror images, same chemical properties (i.e. b.p., m.p., solubility; can NOT separate except w/ chiral chromatography) but diff. interaction w/ plane polarized light – optically active
Rotates plane polarized light
Stereochemistry Part 1 - KEY

c.w. = dextrorotatory (+, d) could be R or S
c.c.w. = levorotatory (-, l)  R or S

Polarimeter

\[
\text{Lt source (Na D-line, 589 nm)} \quad \text{Detector (observed rotation, } \alpha) \quad \text{Sample}
\]

\[
\text{polarizers}
\]

specific rotation \([\alpha]\) – characteristic of compound (Tbl 5.1, pg 214)
\[
[\alpha]_\lambda = \frac{\alpha}{\ell c}
\]

enantiomeric excess (ee) – how much excess of an enantiomer is in a mix
\[
ee = \frac{\alpha_{\text{obs}}}{[\alpha]} \times 100\%
\]

**Vocabulary**

**Racemic mixture (a.k.a. racemate)** – contains equal amounts of d and l enantiomers and so does NOT rotate plane polarized light, use (±) to denote.

**Diastereoisomer** – stereoisomers that are NOT enantiomers, diff. physical and chemical properties (can separate).

**Meso compound** – compound w/ 2+ asymm centers & plane of symmetry (NO enantiomers), is achiral.

If a compound w/ 2 asymm centers has SAME 4 groups bonded to each, 1 stereoisomer (R,S or S,R) will be meso compound.

If a compound w/ 2 asymm centers is cyclic, the cis-isomer will be meso compound.

**Asymmetric center/chiral center** – C bound to 4 diff atoms/groups

**Stereocenter/stereochemical center** – asymmetric center or sp\(^2\), sp\(^3\) Cs where cis-trans occurs

**R, S naming system (for naming enantiomers)**

R – rotates right, clock-wise  S – rotates left, counter-clock-wise

If more than 1 asymm center, determine R or S for each center.

1. Rank atoms/groups attached to asymm. center according to priority
   1. (highest priority) to 4 (lowest priority)
   a. inc. Z (atomic #) inc priority
   b. if Z same (i.e. 2 Cs), look @ Zs of next atoms
c. if atom double bonded, treat as if bound to 2 of those atoms; if triple bonded, treat as if bound to 3 of those atoms
d. if atom has isotopes, use A (mass #) to determine relative priority

2. Orient molec so that 4 (group with lowest priority) is away from you (vertical bond in Fischer Proj.) and draw arrow from 1 to 2.
   If c.w./right then R
   If c.c.w./left then S

EX.

(3R)-pent-1-en-3-ol

N and P as asymmetric centers

Amine inversion – if lone pair on N, rapid interconversion of enantiomers (sp\(^3\) to sp\(^2\) and back to sp\(^3\)) @ RT and so is achiral. Phosphorous behaves similarly to nitrogen.
(Sulfur is different b/c it has access to d orbitals to make bonds)