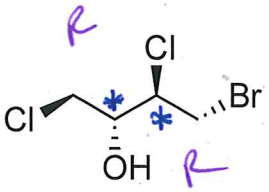
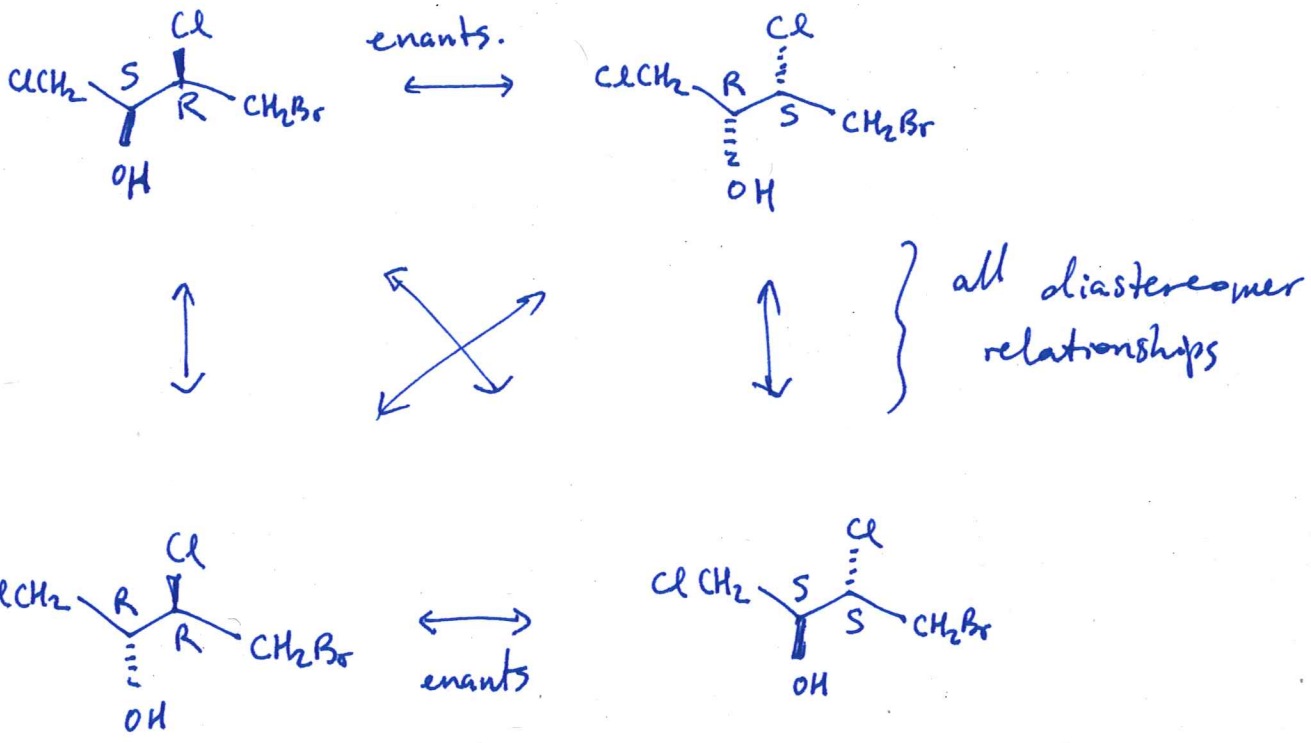
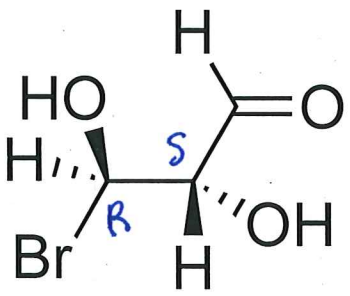
151. Shown below is a single stereoisomer of a compound. Please draw all enantiomers and diastereomers for this compound.
Indicate the enantiomeric and diastereomeric relationships among all the stereoisomers. How many stereogenic centers are there?
For each of the stereoisomers, clearly label ***R*** or ***S*** at every stereogenic center
To ensure you get the maximum credit, please be sure everything is legible and clearly labeled.

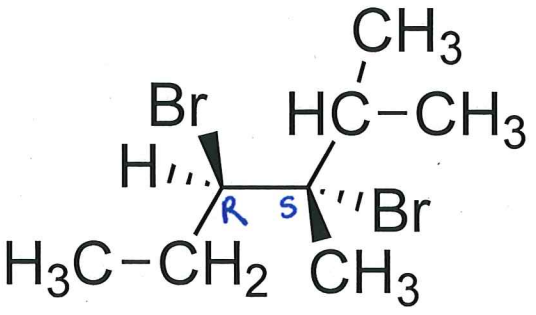




10 2. For the following molecules, label the stereocenters as (*R*) or (*S*).

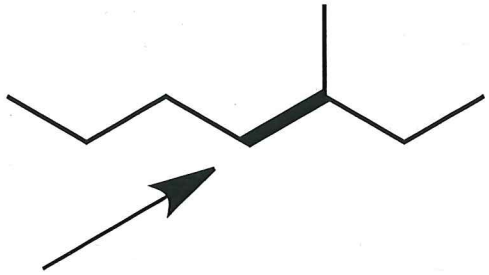


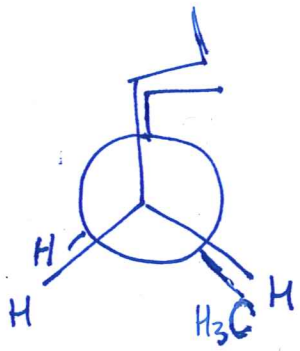
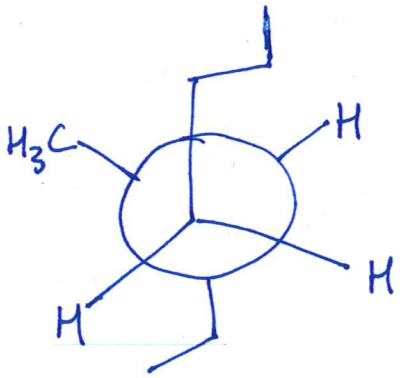
R S



R S

15 3. Please draw a Newman projection for the following compound in its **highest-energy conformation** and its **lowest-energy conformation** around the bond indicated in bold and with an arrow. Put the carbon closer to the arrow in front.



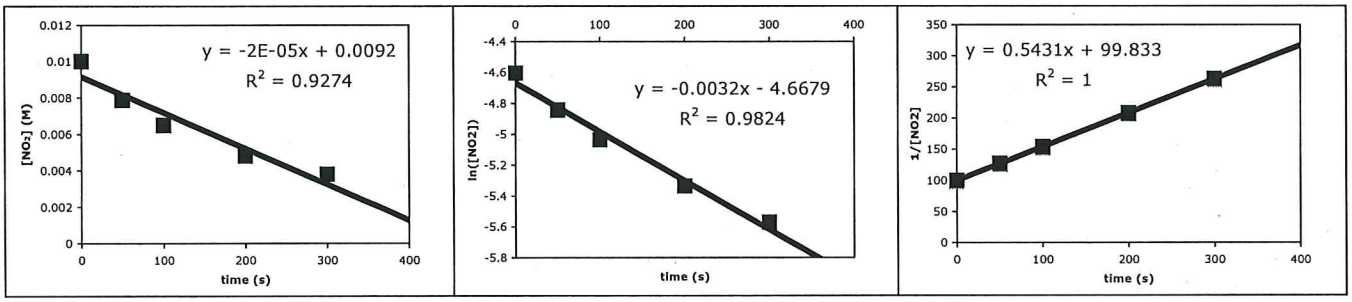
highest-energy conformation	*lowest-energy conformation*
	

20 4. The decomposition of $NO_{2(g)}$ at 300 °C was studied by measuring $NO_{2(g)}$ concentration versus time. The following data were obtained for the reaction:

$$NO_{2(g)} \longrightarrow NO_{(g)} + {}^1/_2\, O_{2(g)}$$

time (s)	$[NO_2]$ (M)
0.0	0.01000
50.0	0.00787
100.0	0.00649
200.0	0.00481
300.0	0.00380

To determine the order of the reaction you make the following plots: $[NO_2]$ vs. t, $\ln[NO_2]$ vs. t, and $1/[NO_2]$ vs. t. For each graph you ask the computer to do a least squares linear fit to the data. The graphs and equations are shown below.



(a) Based on your interpretation of these graphs, is the reaction zero, first, or second order? ***Why?***

5 second order because the graph of $\frac{1}{[NO_2]}$ vs time is linear

(b) Write a rate law for the reaction.

6 $\text{rate} = k[NO_2]^2$

(c) Determine the value of the rate constant k (be sure to use the proper units).

second order, rate = slope

$0.5431\ M^{-1}s^{-1}$

5 4

155. Proponents of collision theory explain the temperature dependence of reaction rates by considering the rate constant k to be the product of three factors:

$$k = \mathbf{Zfp}$$

For example, f is the fraction of molecular collisions that occur with enough energy to get over the activation energy barrier from reactants to products ($f = e^{-Ea/RT}$).

(a) In **one sentence each**, give a definition of the terms Z and p.

3 Z is collision frequency: how many collisions occur in a given amount of time

3 p is an orientation factor: fraction of collisions w/ the correct geometry

(b) According to the collision theory of reactions **why** does temperature affect the rate constant (and the rate) of a reaction? **Give the most important factor.** If you discuss more than one factor, be sure to indicate which factor is the most important.

9 the most important factor is f. It has an exponential dependence on temperature, so a small change in T leads to a big change in f.

156. When fossil fuels are burned in air, nitric oxide (NO) is formed. Further reaction of nitric oxide with oxygen occurs according to the following equation:

$$2\,NO_{(g)} + O_{2(g)} \longrightarrow 2\,NO_{2(g)}$$

At 25 °C, the following rate data were collected:

2nd order in [NO]

Experiment #	initial concentrations (M) [NO]	[O_2]	Initial rate (M/sec)
1	0.0020	0.0010	2.8×10^{-5}
2	0.0040	0.0010	1.1×10^{-4}
3	0.0020	0.0020	5.6×10^{-5}

×2 → ×4 (Exp 1 → 2); ×2 → ×2 (Exp 2 → 3); ×4 (Exp 1 → 2)

1st order in [O_2]

(a) Determine the rate law for the reaction.

5 $\text{rate} = k[NO]^2[O_2]$

(b) What is the rate constant for this reaction? (be sure to use proper units) 3 2

5 $k = \dfrac{\text{rate}}{[NO]^2[O_2]} = \dfrac{2.8\times10^{-5}\ M/s}{(0.002)^2_M(0.001)_M} = 7.0\times10^{3}\ M^{-2}s^{-1}$

(c) A fourth experiment was conducted for which initial concentrations were [NO] = 0.0125 M and [O_2] = 0.0060 M. What was the initial rate of this reaction?

$\text{rate} = (7000)(0.0125)^2(0.006) =$ ~~0.525~~ 6.6×10^{-3} M/s

3 2

107. For the reaction given below, answer the following questions:

$$5\ Br^-_{(aq)} + BrO_3^-{}_{(aq)} + 6\ H^+_{(aq)} \longrightarrow 3\ Br_{2(aq)} + 3\ H_2O_{(l)}$$

(a) In words describe how the rate of formation of Br_2 is related to the rate of disappearance of H^+.

Br_2 appears at $\frac{1}{2}$ the rate that H^+ disappears.

2

(b) If the rate of appearance of Br_2 is 6.33×10^{-4} M/sec, what is the rate of disappearance of BrO_3^-?

8

$$\frac{1}{3}\frac{\Delta[Br_2]}{\Delta t} = -\frac{\Delta[BrO_3^-]}{\Delta t}$$

$$\frac{\Delta[BrO_3]}{\Delta t} = -2.11 \times 10^{-4}\ M/s$$

Rate of disappearance $= +2.11 \times 10^{-4}\ M/s$