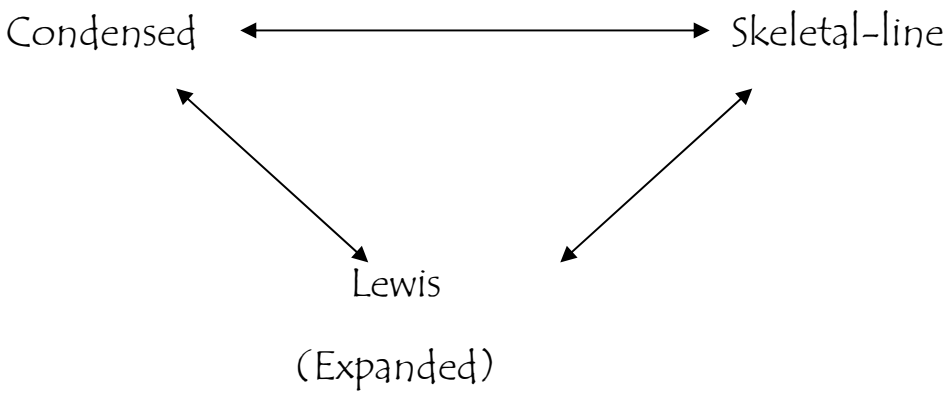
Chapter 9

Hydrocarbons & their Structure

Hydrocarbons Part 1: Structural Formulas

Structural Formulas for Organic Molecules



Neutral Bonding Patterns for Organic Compounds

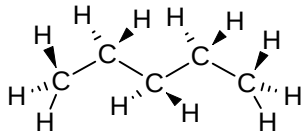
Periodic Table of the Elements

1 Group IA	2 Group IIA	3 Group IIIB	4 Group IVB	5 Group VB	6 Group VIB	7 Group VIIB	8 Group	9 Group VIIIB	10 Group	11 Group IB	12 Group IIB	13 Group IIIA	14 Group IVA	15 Group VA	16 Group VIA	17 Group VIIA	18 Group VIIIA
1 H 1.01																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.30											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.84	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57 La 138.91	72 Hf 178.49	73 Ta 180.95	74 W 183,84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (269)	109 Mt (268)	110 – (271)	111 – (272)	112 – (277)		114 – (289)		116 – (289)		118 – (293)

58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (248)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (260)	102 No (259)	103 Lr (262)

Skeletal Line Structures

Carbon atoms can form long chains with branches. The tetrahedral electron geometry results in the carbon atoms forming a zigzag shape. Skeletal-line drawings show the carbon skeleton at the end of each line and at each corner.



Guidelines for Writing Skeletal-Line Structures

Rule 1: All carbon-carbon single bonds are shown as a single line

Rule 2: Double bonds are shown as two parallel lines
Triple bonds are shown as three parallel lines

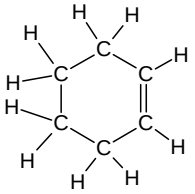
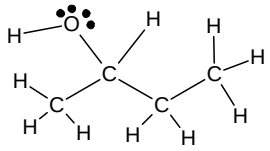
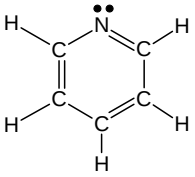
Rule 3: The chemical symbol of carbon, C, is omitted. The presence of a carbon atom is implied wherever two lines join and at the end of a line. A continuous carbon chain is represented as a zigzag arrangement of lines.

Rule 4: Heteroatoms are atoms other than carbon or hydrogen and must be written.

Rule 5: Hydrogen atoms must be drawn on heteroatoms and the carbons of aldehyde groups.

Note: Since carbon atoms ALWAYS have 4 bonds, you can determine the number of H atoms bonded to a particular carbon atom by counting the number of bonds and subtracting this value from 4.

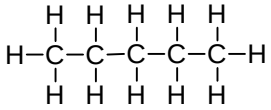
Practice

Lewis Structure	Skeletal-line Structure
	
	
	

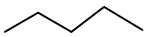
Condensed Structures

Because the carbon atoms form the backbone of the skeleton, it is also common to omit the bonds and only show the atoms. Double and triple bonds are often still shown.

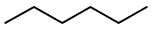
The following three structures ALL represent the same compound:

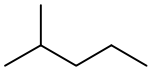


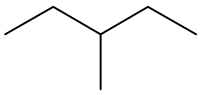
$CH_3CH_2CH_2CH_2CH_3$

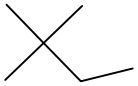


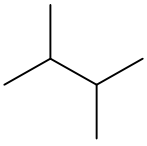
Write the condensed structures for the 5 structural isomers of C_6H_{14}.







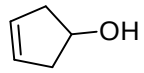




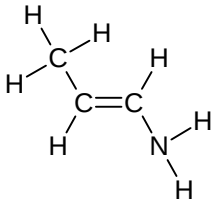
Here are "4 different ways" to describe an organic compound:

Molecular Formula vs Lewis Structure vs Bond-Line vs Condensed

Draw these compounds the "other 3 ways" & add the lone pair electrons.



$(CH_3)_2CHCH_2CHO$

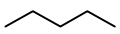


Hydrocarbons Part 1b: The Homologous Series

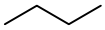
Root Names – the Homologous Series

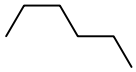
# C's	Alkane Structure	Suffix name	Substituent name
1		methane	methyl
2		ethane	ethyl
3		propane	propyl
4		butane	butyl
5		pentane	pentyl
6		hexane	hexyl
7		heptane	heptyl
8		octane	octyl
9		nonane	nonyl
10		decane	decyl

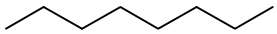
Name the following hydrocarbons using the homologous series.

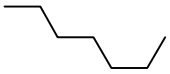
a) 

b) 

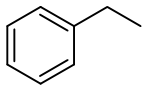
c) 

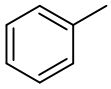
d) 

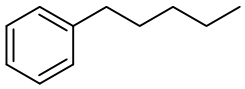
e) 

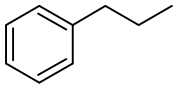
f) 

Name the hydrocarbon branches on the benzene rings below.

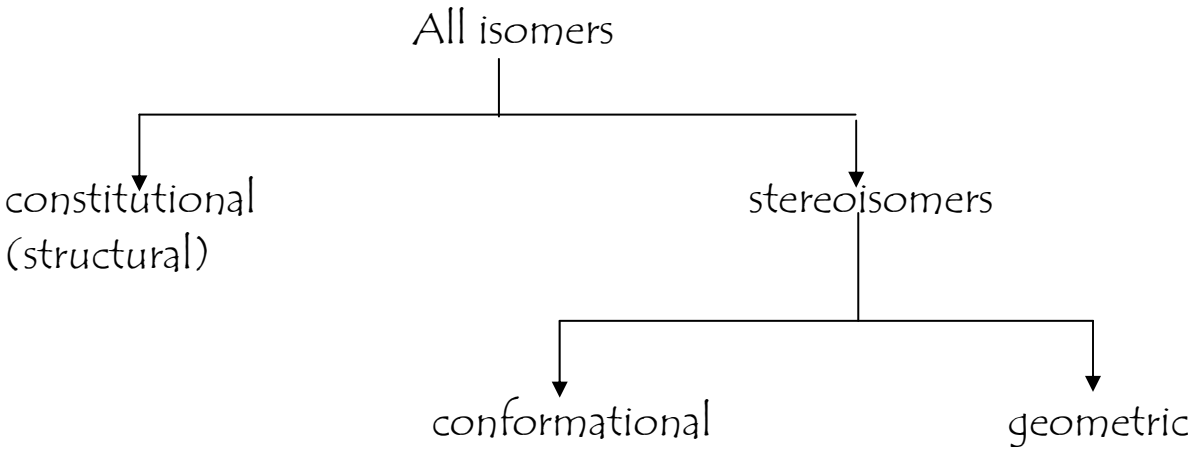
a) 

b) 

c) 

d) 

Hydrocarbons Part 2: Introduction to Isomers



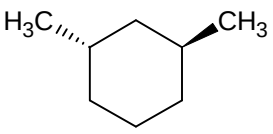
structural isomers: compounds with the SAME chemical formula, but DIFFERENT connectivity of atoms

conformers: same compound with different rotation around C-C

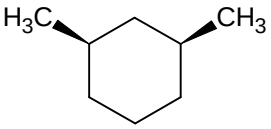
geometric isomers: compounds with the same connectivity between atoms, yet different spatial arrangements

Geometric Isomers: A closer look

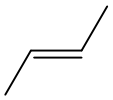
Cis & Trans isomers can NOT inter-convert. They are unique cpds.



trans-1,3-dimethylcyclohexane

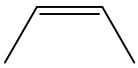


cis-1,3-dimethylcyclohexane



trans-2-butene

mp -139C & bp -4C



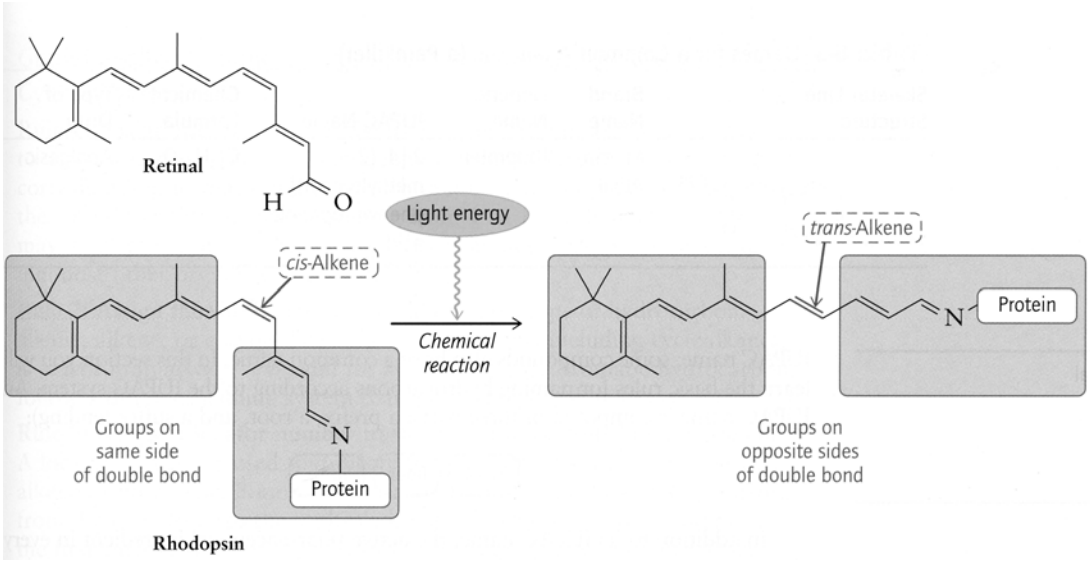
cis-2-butene

mp -106C & bp 1C

Cis-Trans Isomers in Biochemistry

Isomerization reaction: a chemical reaction that converts one structural isomer or geometric isomer into another

The retina of the eye contains 2 types of photoreceptors: rods and cones. The rods contain a polyene known as retinal which is part of a larger protein known as rhodopsin. Light induces one of the cis- double bonds to undergo isomerization reaction to a trans double bond causing the entire molecule to change shape which initiates a nerve impulse that travels along the optic nerve to the brain resulting in a visual image.

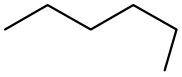


Draw the 5 structural isomers with the molecular formula C_6H_{14} using skeletal-line structures.

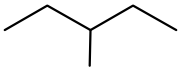
What are the relationships between compounds A, B and C?

A

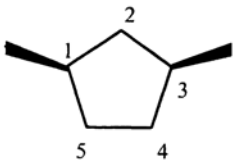
B



C



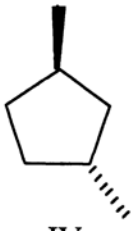
What are the relationships between Cpd I and other Cpds II to VII?
Are they identical (I), structural isomers (SI), or geometric isomers (GI)?



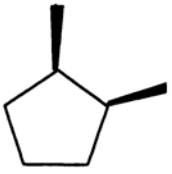
I

II

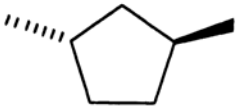
III



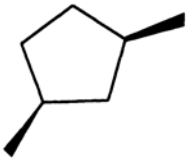
IV



V

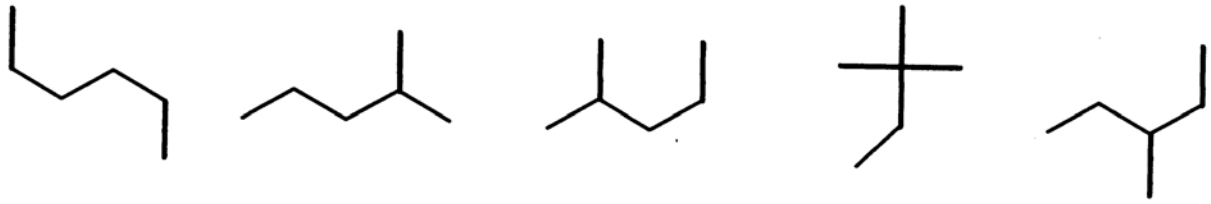


VI



VII

Use the following compounds to answer the questions below.



A B C D E

a) Which compounds are structural isomers?

b) Which compounds are conformers?

Label the following double bonds as cis or trans if applicable.