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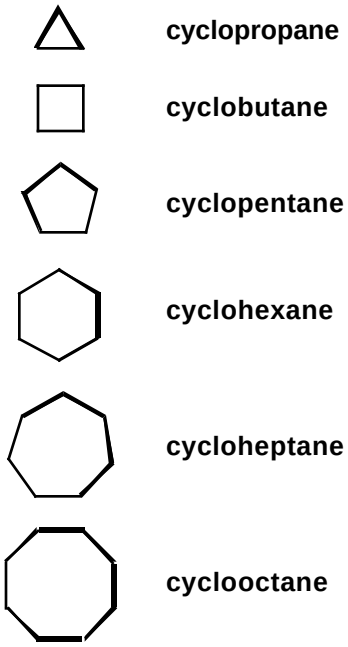
Having explored straight- and branched-chain (aliphatic) hydrocarbons in some detail, we can initiate a fruitful extension of the ideas developed so far, applying them now to a discussion of rings. For the present we will continue to adhere to examples from the hydrocarbon series.



cyclic hydrocarbons

Minimal tinkering will suffice to make clear that models of cyclic molecules such as cyclopentane, cyclohexane, cycloheptane, and so forth, are easy to build, so that the existence of the molecules themselves is not unexpected. However, depending upon the nature of the model set, and the rigidity of its tetrahedral angles, it may be more difficult to construct models of cyclobutane and cyclopropane: the models suggest that these two molecules should be quite strained. In fact, cyclobutane and cyclopropane do exist, and furthermore it is possible to determine quantitatively that they are, indeed, strained, if strain is defined as a raising of the

internal energy. A brief elaboration of the strain energy concept will be instructive here. When we burn two hydrocarbons, such as n-heptane and n-hexane, that differ by a single methylene unit (—CH_2—), we can interpret the value of the difference between their heats of combustion (-157.4 kcal/mole) as providing a very close estimate of the heat of combustion of an "unstrained" methylene unit.

Combustion of n-heptane:	$C_7H_{16} + 11O_2$	$\longrightarrow$	$7CO_2 + 8H_2O$	ΔH_1
Combustion of n-hexane:	$C_6H_{14} + 9.5O_2$	$\longrightarrow$	$6CO_2 + 7H_2O$	ΔH_2
Difference:	$- CH_2 - + 1.5O_2$	$\longrightarrow$	$CO_2 + H_2O$	$\Delta\Delta H$ = **(-)157.4 kcal/mole**

In the next segment we shall see how this number can be used to give a quantitative estimation of the strain energy in hydrocarbon ring systems.