OCSP 2020-Lecture 13

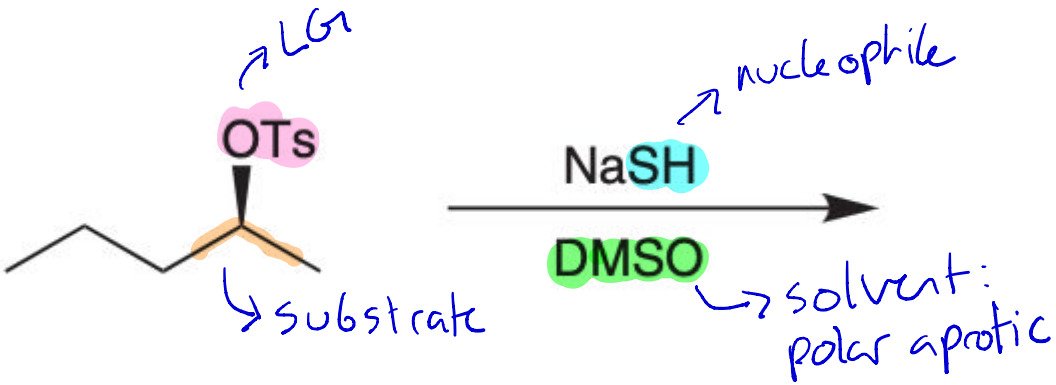
Today’s Agenda

- Comparing our 4 big reactions: SN1, SN2, E1, and E2
- Bredt’s Rule

Remember that reactions often come in pairs

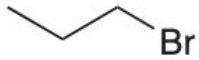
- SN1 reactions frequently accompany E1 reactions
- SN2 reactions frequently accompany E2 reactions

Factors to evaluate in a scenario



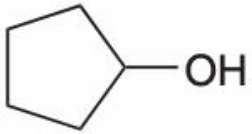
Factor 1: The alkyl substrate

- If you see a primary substrate- must be an SN2 or E2 reaction



- Not stable for a carbocation intermediate in SN1 & E1
- If you see a tertiary substrate- must be SN1, E1, or E2

- backside attack in SN2 is difficult due to steric
- If you see a secondary substrate-can't rule anything out!



- all 4 reactions possible!

Factor 2 to evaluate: Solvent

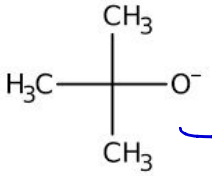
examples: H_2O & CH_3OH (great + & - solvation)

- Remember: polar protic solvents favor SN1 and E1
- Polar aprotic solvents like DMSO favor SN2 reactions → allows nucleophile to move quickly (+ solvation only)
- E2 reactions can occur in polar aprotic or polar protic solvents

Factor 3 to evaluate: attacking molecule

Nucleophile or Base, or both

- Molecules which are only nucleophiles: → typically just SN1 & SN2 → look at substrate
  - -SH, H_2S, any halides (Cl-, Br-, I-) too weak to usually act as bases
- Molecules which are strong nucleophiles and bases: → usually SN2 or E2
  - -OH, $-OCH_3$
- Molecules which are only strong bases: → E2
  - Tert butoxide: NaH, $-OC(CH_3)_3$



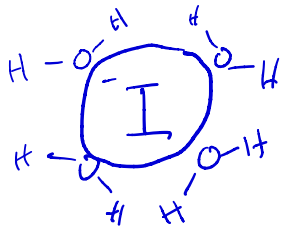
→ Big, bulky, base

- Molecules which are weak nucleophiles and bases → often seen in solvolysis reaction
  - H_2O and MeOH

→ SN1 + E1

Solvent effects on Nucleophiles

- Equal effects on nucleophiles which are same size
- In polar aprotic solvents: smaller nucleophiles are better
  - No anion (-) solvation or H bonding
  - Easier for smaller Nu to move faster
- In polar protic solvents: larger Nu are better
  - Both anion and cation solvation, as well as H bonding
  - Larger molecules are not solvated as easily, can “push through” better



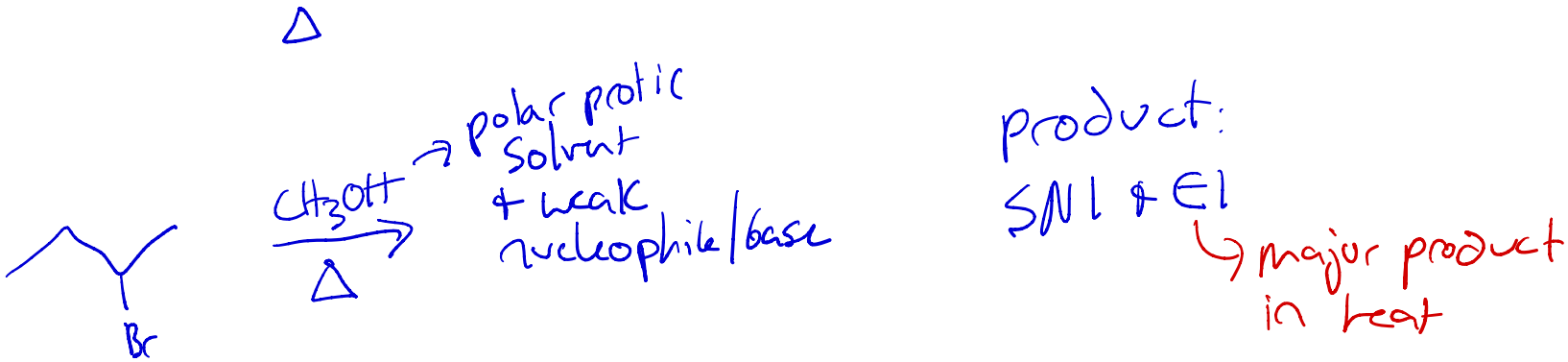
Practice: Which nucleophile will react the fastest in DMSO?

↳ polar aprotic solvent

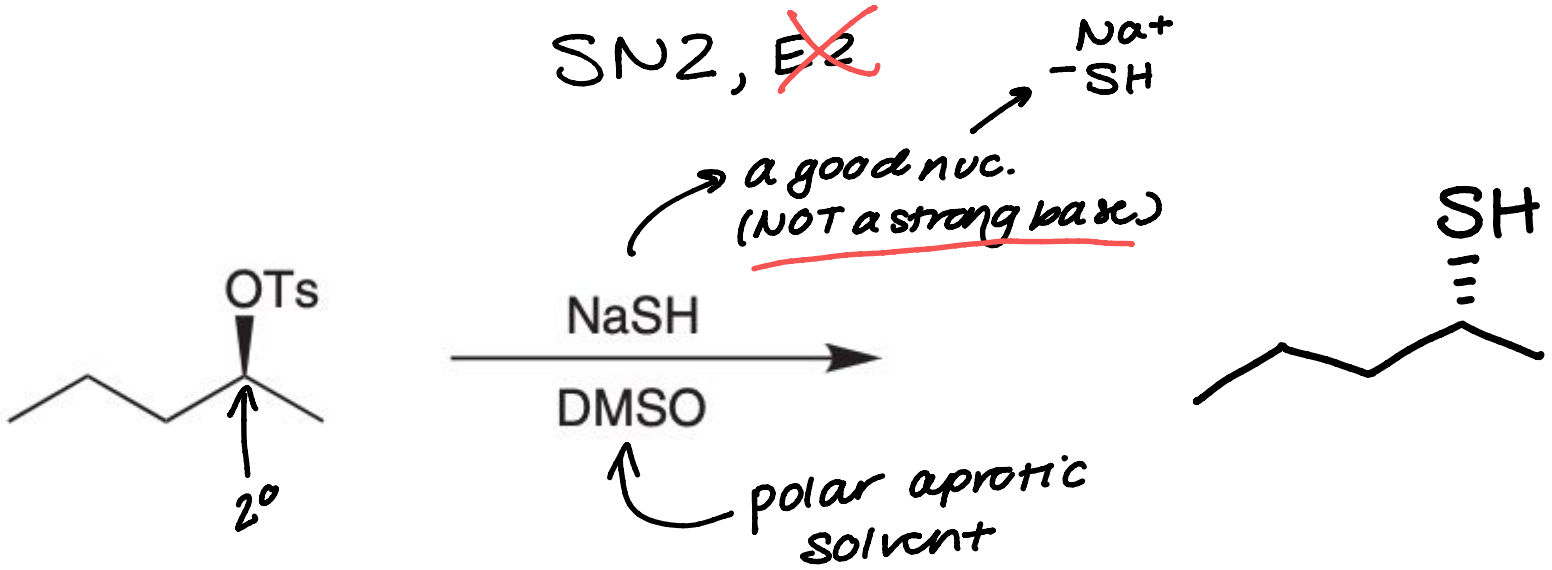
	-I	F-	Cl-	Br-
in polar aprotic:	4	1	2	3
in polar protic:	1	4	3	2

Other factors to consider

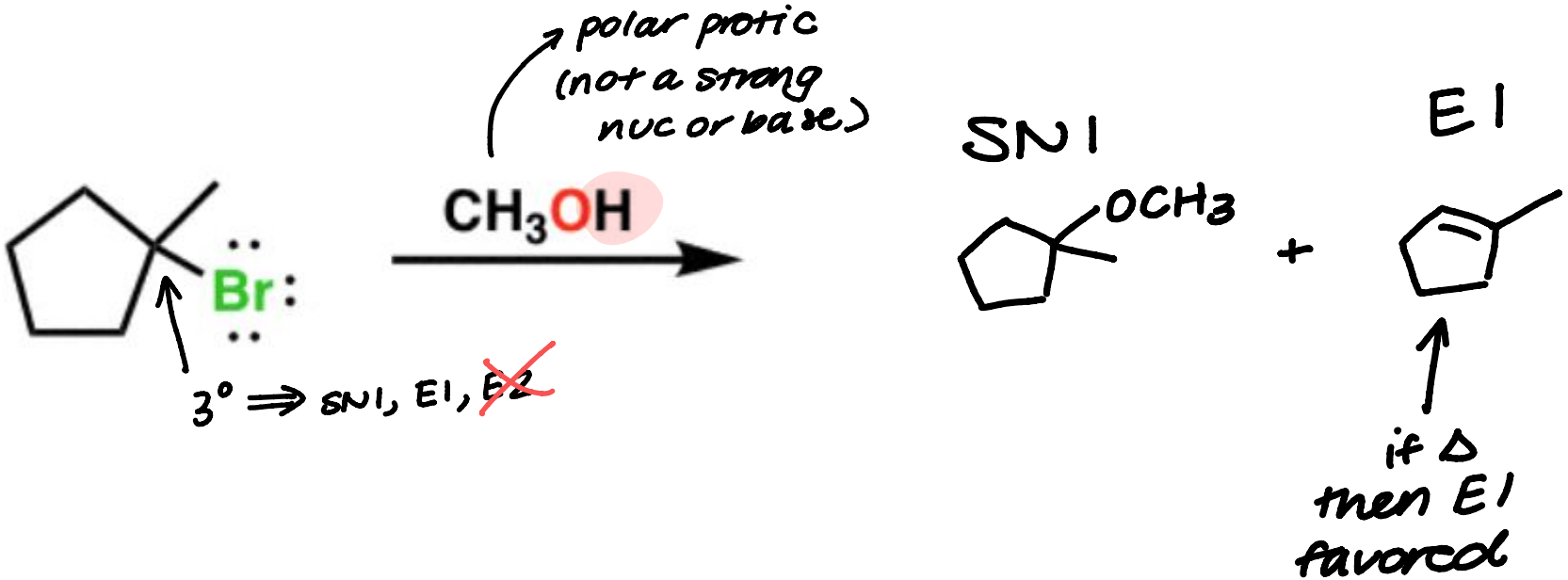
- Remember temperature: heat favors E1 reactions



Back to our original example:

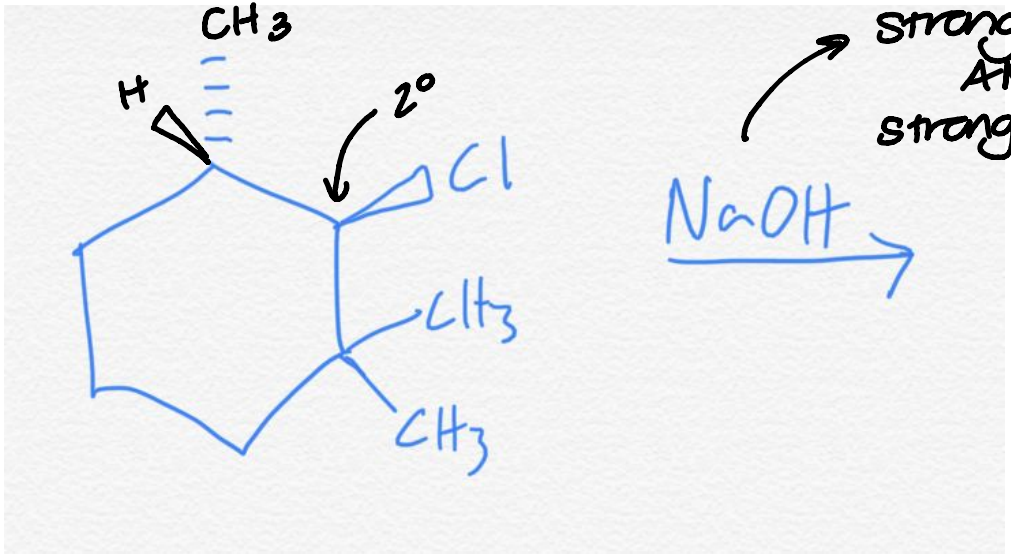


Practice


polar protic
(not a strong
nuc or base)
CH_3OH
Br:
3° ⇒ SN1, E1, E2
SN1
OCH_3
+
E1
if Δ
then E1
favored

Practice

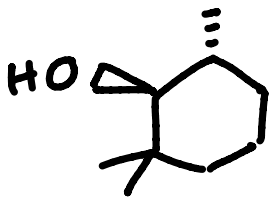
SN2, ~~E2~~ → take off anti H



strong base AND strong nuc.

NaOH →

SN2



\+

E2

~~H~~ is not anti to the LG

Quick Review of Ring Compounds

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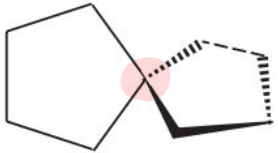
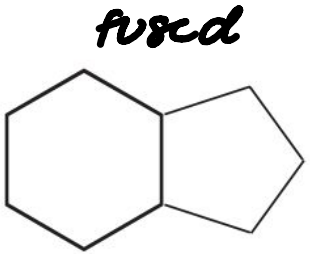
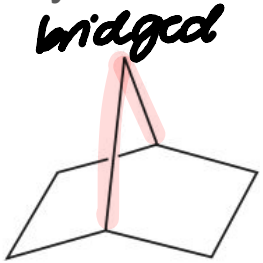
- **Polycyclic compound** = > 2 rings with many common atoms



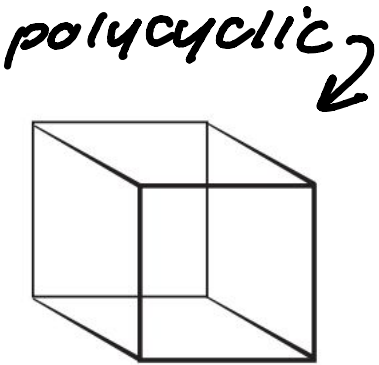
spiro[4.4]nonane



bicyclo[4.3.0]nonane



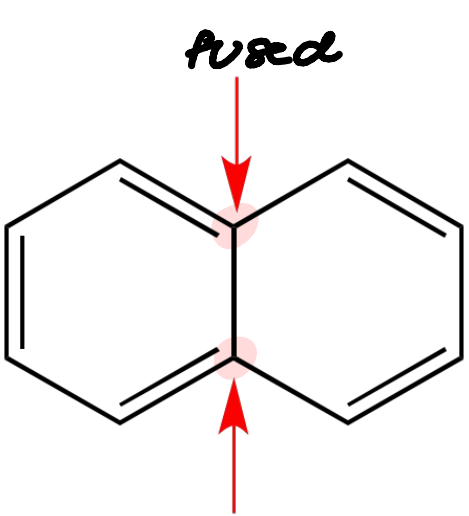
bicyclo[2.2.1]heptane

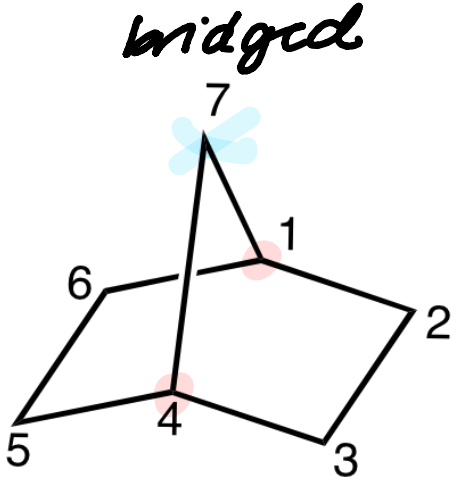


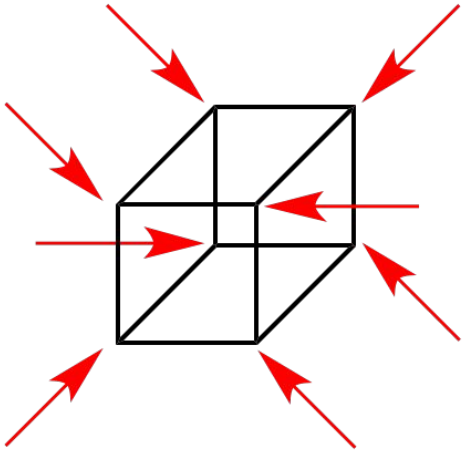
cubane

Quick Review of Ring Compounds (cont.)

- **Bridgehead atom:** in a polycyclic molecule, an atom that is part of 2+ rings







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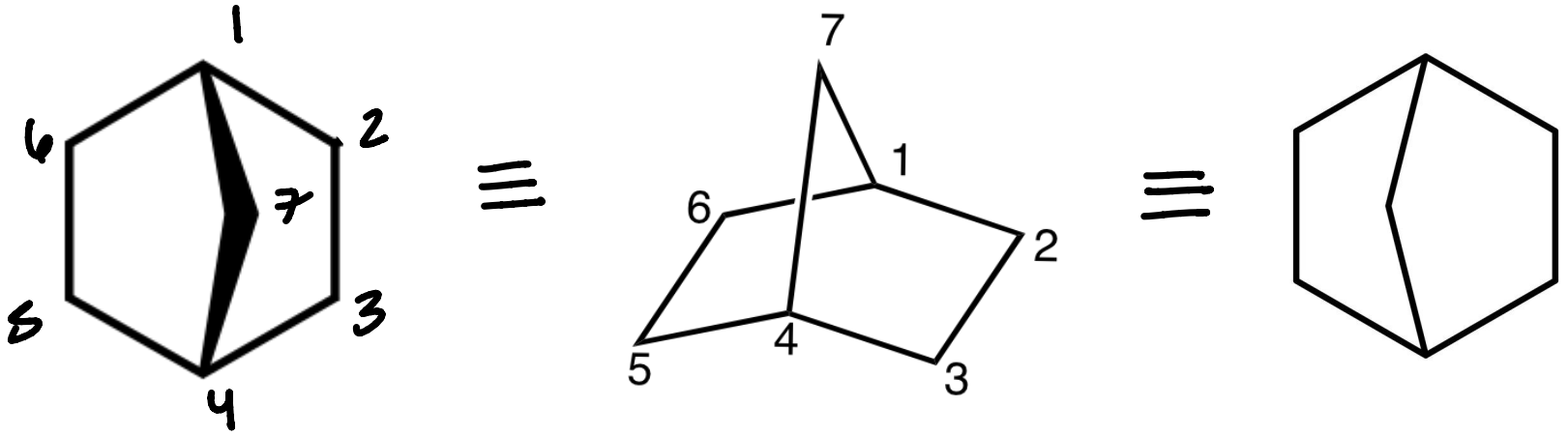
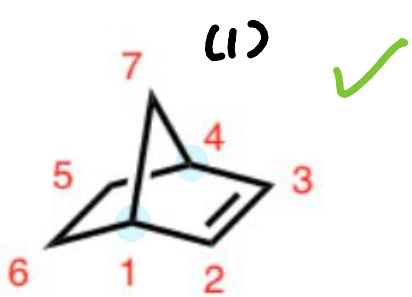
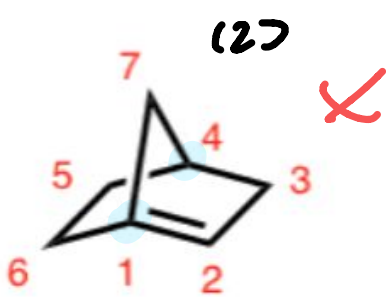
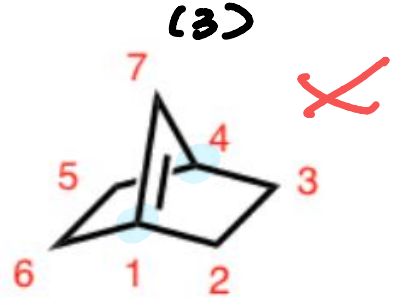


Bredt's Rule | For bridged bicyclic rings!

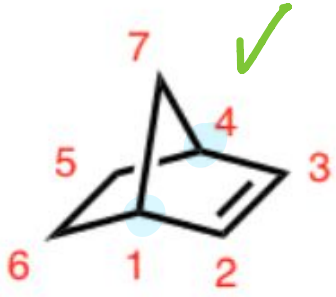
- For a ring system **< 8 carbons**, you *cannot* have a double bond on a bridgehead atom
- Why doesn't it work?
  - Adjacent p orbitals on C=C don't overlap well :(
  - If you try to build a model, you have to twist the C=C
- A few exceptions to this rule (anti-bredt molecules), but don't worry about



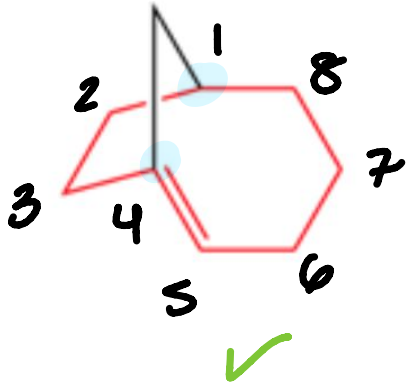


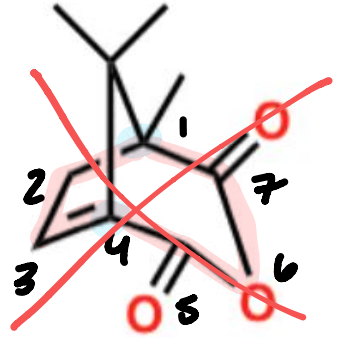


Practice | Which of the following molecules follow Bredt's rule?



< 8 carbons

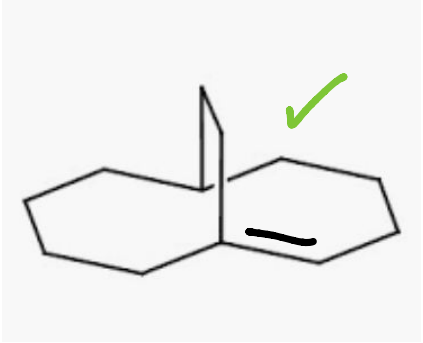


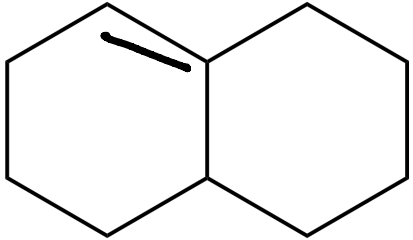


breaking bredts rule

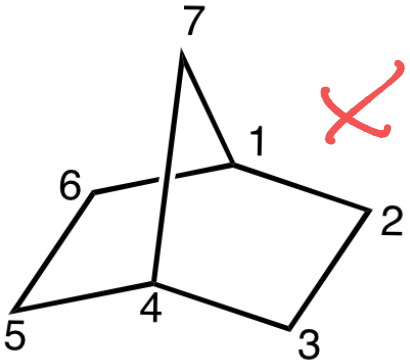
Practice | Which could have double bonds at bridgehead atoms?

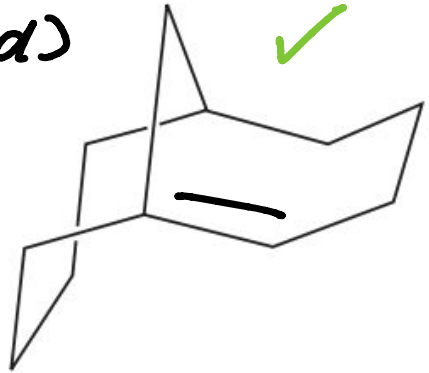
Bredt's rule: < 8 carbons = no double bond ∴





fused (not bridged)





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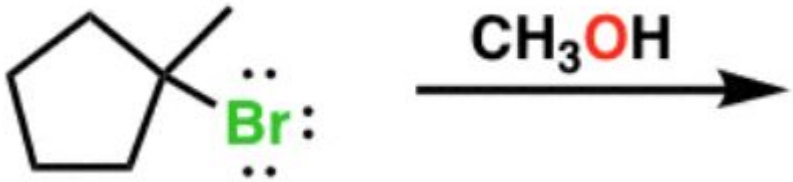

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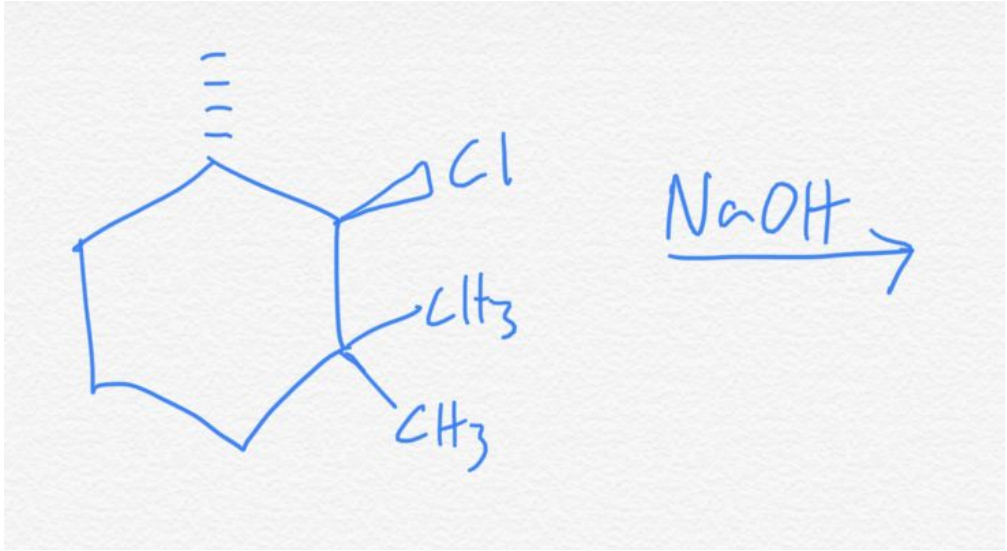

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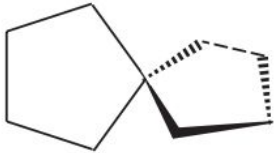

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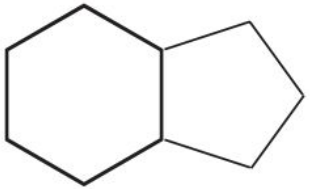

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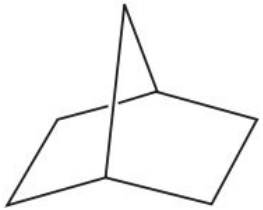

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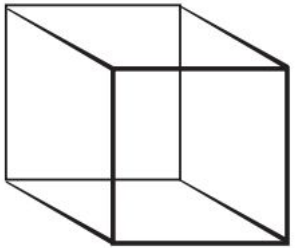

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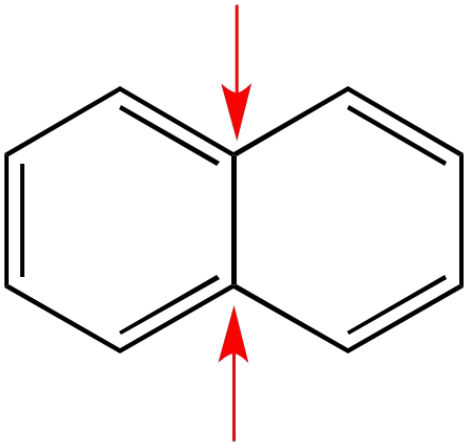

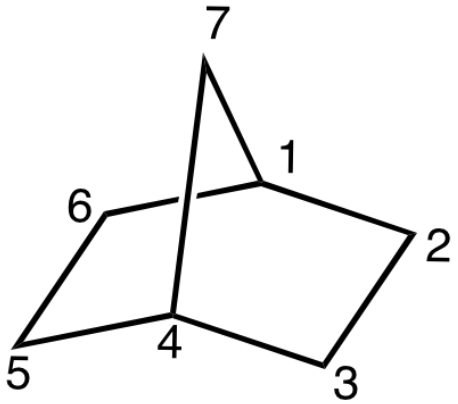

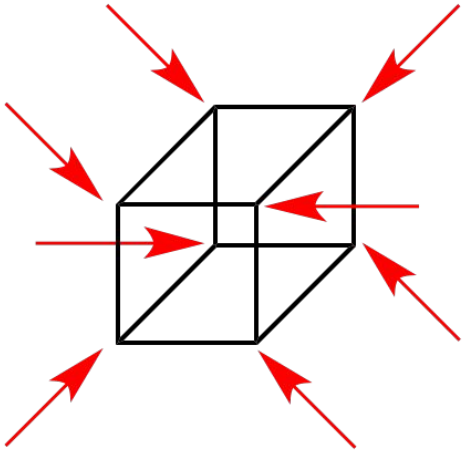

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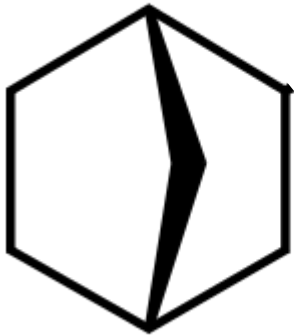

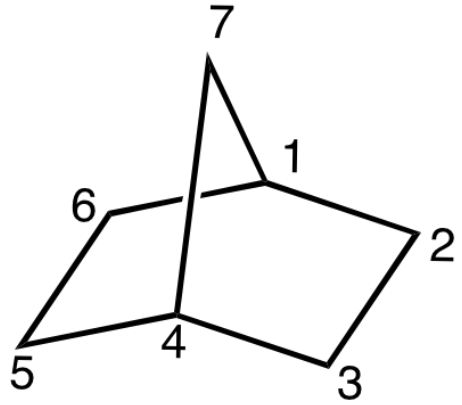

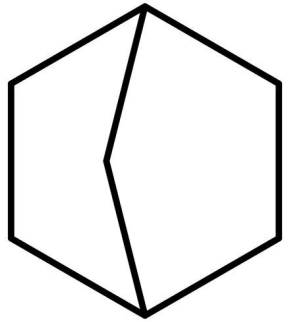

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  - (Sometimes other atoms are part of the “ring,” but not nearly as common)
- Why doesn’t it work?
  - Adjacent p orbitals on C=C don’t overlap well :(
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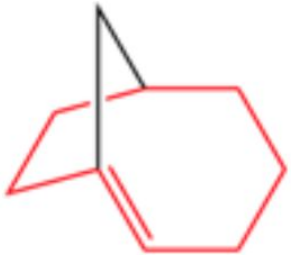

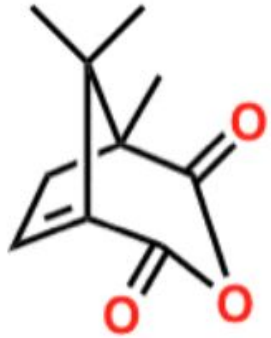

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