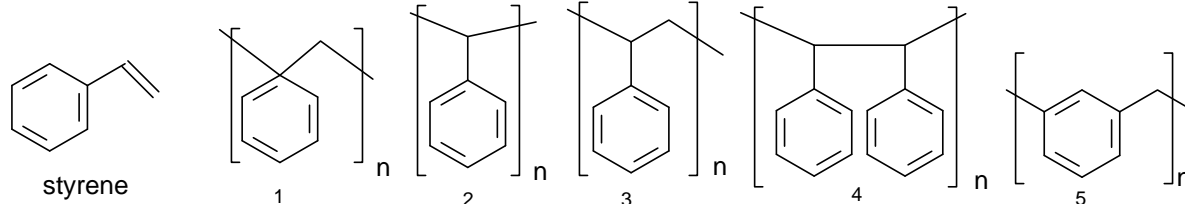


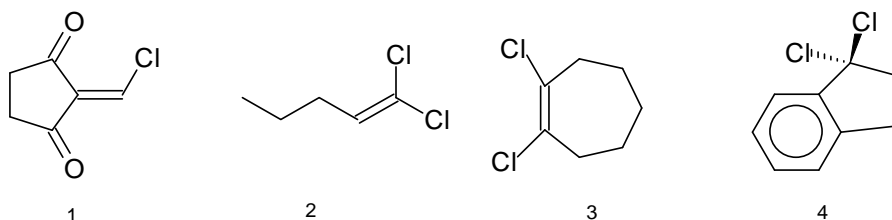
MARK ONE ANSWER FOR EACH QUESTION ON BOTH THE EXAM AND YOUR SCANTRON!

1. What is the repeat unit of the polymer that forms when styrene is polymerized?



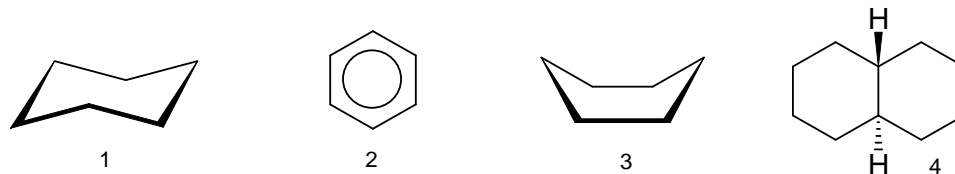
A. 1 B. 2 C. 3 D. 4 E. 5

2. Which of the compounds below can have both a *cis* and a *trans* isomer?



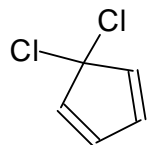
A. only 1 B. only 2 C. only 3 D. only 4 E. none of them

3. Which of the following molecules would you expect to have angle strain?



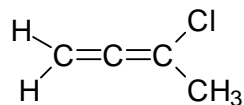
A. only 1 B. only 2 C. only 3 D. both 3 and 4 E. none of them

4. What is the best name for the molecule below?



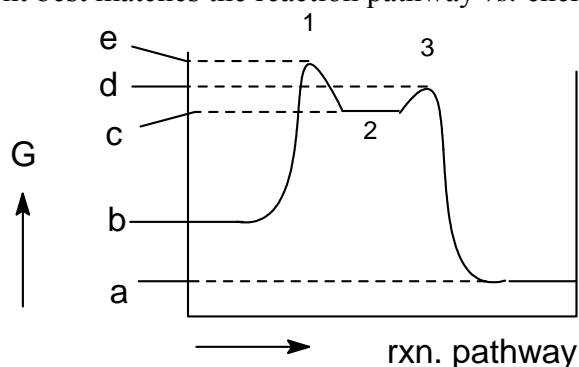
A. dichloro-1,3-cyclopentadiene B. 3,3-dichloro-1,4-cyclopentadiene
 C. *cis, cis*-5,5-dichloro-1,3-cyclopentadiene D. 5,5-dichlorocyclopentadiene
 E. 5,5-dichloropentadiene

5. What is the best name for the molecule below?



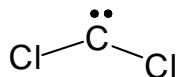
A. *cis*-3-chloro-1,2-butadiene B. 3-chloro-1,2-butadiene C. 3-chlorobutadiene
 D. (E)-3-chloro-1,2-butadiene E. 1-chloro-1-methylpropadiene

6. What statement best matches the reaction pathway vs. energy diagram below?



- A. This reaction is exothermic
- B. The difference between positions *c* and *e* on the energy axis is called “activation energy”
- C. This reaction has one transition state
- D. This reaction requires a catalyst
- E. The change in free energy, ΔG , for this reaction is negative

7. Select one correct statement about dichlorocarbene, shown below:

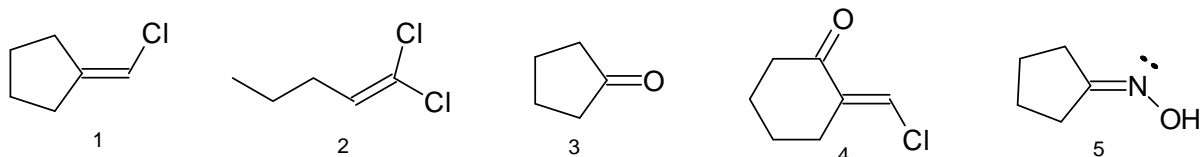


- A. This compound is a key intermediate in the Simmons-Smith reaction
- B. The central carbon of this compound is sp hybridized
- C. This compound is a radical
- D. This compound is a good electron pair donor
- E. This compound reacts with cyclohexene to generate $\text{C}_7\text{H}_{10}\text{Cl}_2$

8. What is the major product of the reaction of carbene ($:\text{CH}_2$) with (*Z*)-2-butene:

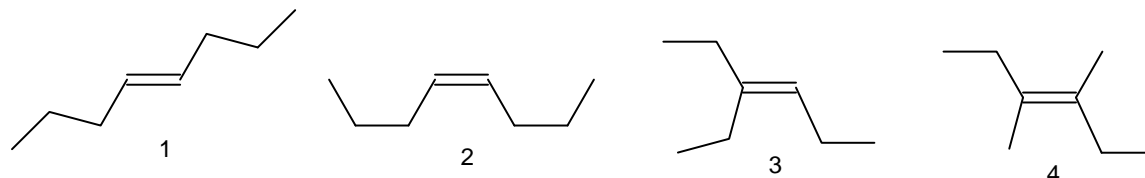
- A. (*Z*)-2-pentene
- B. (*E*)-2-pentene
- C. *trans*-1,1-dimethylcyclopropane
- D. *cis*-1,2-dimethylcyclopropane
- E. 1,2-dimethylpropane

9. Which of the compounds below are *Z* isomers?



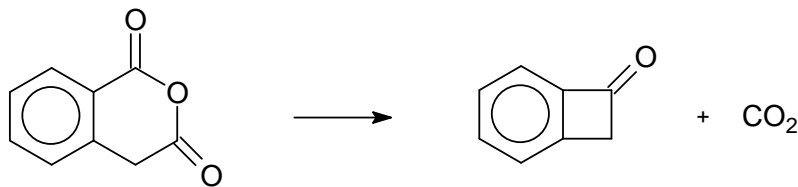
- A. only 1
- B. only 2
- C. only 3
- D. only 4
- E. none of them

10. Which alkene would you expect to release the least amount of heat during hydrogenation?



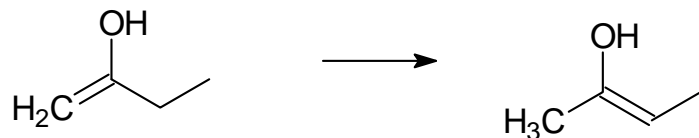
- A. 1
- B. 2
- C. 3
- D. 4
- E. can't tell, they have different numbers of carbons

11. What is the reaction below?



- A. an addition B. an elimination C. a substitution D. a rearrangement
E. none of the previous

12. What is the reaction below?



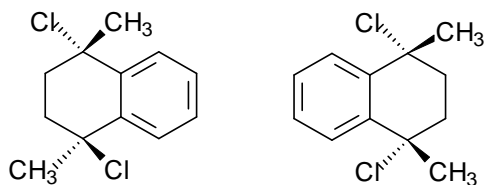
- A. an addition B. an elimination C. a substitution D. a rearrangement
E. a conformational change

13. What is the relationship between the two structures below?



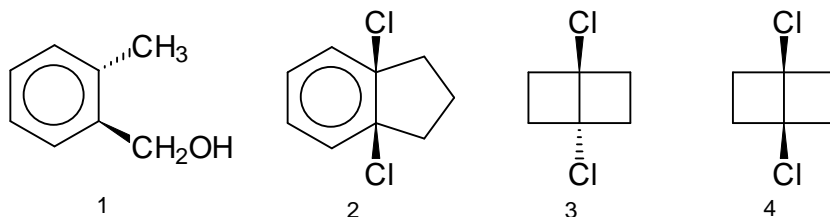
- A. resonance forms B. stereoisomers C. they are identical D. conformers
E. constitutional isomers

14. What is the relationship between the two structures below?



- A. resonance forms B. stereoisomers C. they are identical D. conformers
E. constitutional isomers

15. Which of the following are VALID representations (don't violate basic rules of structure and bonding)?



- A. 1 only B. 2 only C. 3 only D. 4 only E. none of them are possible

16. What best describes the hydroboration sequence?

- A. It follows Markovnikov's rule
- B. It requires boron trifluoride
- C. It converts cyclohexene to cyclohexanol
- D. It results in the formation of products that are *syn* isomers
- E. It requires a hydride donor

17. Why are tertiary carbocations more stable than primary ones?

- A. Because tertiary carbocations are sp^3 hybridized while primary ones are sp hybridized
- B. Because of hyperconjugation.
- C. Because tertiary carbocations are sp^2 hybridized while primary ones are sp^3 hybridized
- D. Because primary carbocations are electron deficient while tertiary ones are not
- E. Because empty antibonding π orbitals in tertiary carbocations are partially filled with electrons from an adjacent sp^3 hybrid orbital.

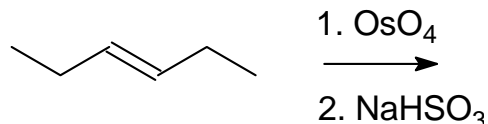
18. Which hydrocarbons are gases under ambient conditions (1 atm., 24° C)?

- A. ethane and propane are gases, butane, pentane and hexane are liquid
- B. ethane, propane and butane are gases, pentane and hexane are liquid
- C. ethane, propane, butane and pentane are gases, hexane is liquid
- D. ethane, propane, butane, pentane and hexane are all gases
- E. ethane and butane are gases, propane, pentane and hexane are liquid

19. What statement best matches the term "Non-Hammond" behavior?

- A. The transition state of a reaction is lower in energy than its intermediate
- B. The reaction displays "New Orleans" behavior
- C. The slower one of alternate reaction pathways leads to the more stable intermediate
- D. ΔH of the reaction is negative while ΔS is positive
- E. ΔH of the reaction is positive while ΔS is negative

20. What best describes the outcome of the following experiment:



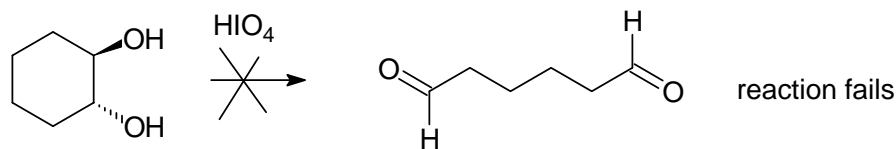
- A. This is an example of a hydration reaction
- B. This experiment will generate a *syn*-diol
- C. This experiment will generate a diol
- D. This experiment will fail because a *trans* (rather than *cis*) alkene was used
- E. This reaction follows Markovnikov's rule

21. Complete the following sentence:

"In an oxymercuration reaction, the mercury acetate..."

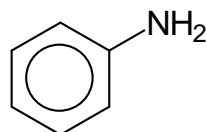
- A. is a nucleophile
- B. is an electrophile
- C. is a catalyst
- D. forms a bromonium ion
- E. donates a lone pair

22. The attempted oxidation shown below ended in failure. What is the most plausible reason for this?



- A. Periodic acid does not oxidize diols
- B. This diol cannot form a cyclic periodate intermediate
- C. This diol cannot be oxidized because it is cyclic
- D. Only diols, in which both -OH groups are attached to the same carbon, will be oxidized
- E. Periodic acid oxidations cannot generate aldehydes

23. What is the degree of unsaturation of the compound below?



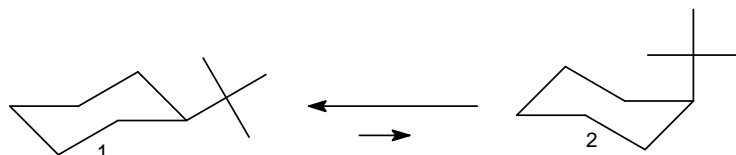
- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

24. What is the degree of unsaturation of the compound below?



- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

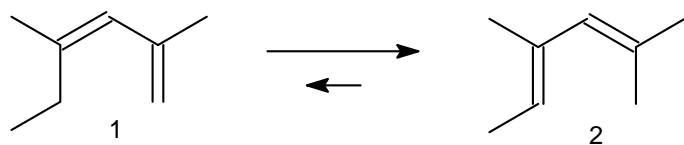
25. The *tert*-butyl group in *tert*-butylcyclohexane tends to be mostly in the equatorial position:



What is the most appropriate statement about this equilibrium?

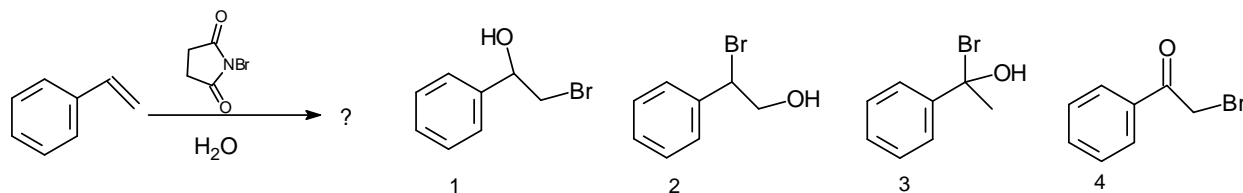
- A. It favors 1 as a result of angle strain in molecule 2.
- B. Molecules 1 and 2 are stereoisomers
- C. The equilibrium favors 1 as a result of a flagpole interaction in molecule 2
- D. The equilibrium favors 1 as a result of 1,3-diaxial repulsion in molecule 2
- E. Molecules 1 and 2 are resonance forms

26. The rearrangement below happens because 2 is more stable than 1. Select the best answer:



- A. Molecules 1 and 2 are conformers
 B. Molecules 1 and 2 are stereoisomers
 C. Molecule 2 is favored because the stability of double bonds increases with increasing substitution
 D. Molecule 2 is favored because only molecule 1 has angle strain
 E. This reaction is an example of an alkyl shift

27. What is the most probable product for the reaction of styrene with N-bromosuccinimide and water?



- A. compound 1 B. compound 2 C. compound 3 D. compound 4
 E. a 1:1 mixture of compounds 1 and 2

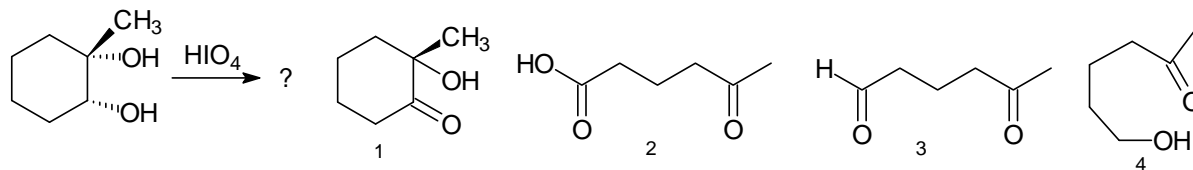
28. What is the most appropriate statement about the angle strain of cycloalkanes C_nH_{2n} (cyclopropane, cyclobutane, cyclopentane,...) ?

- A. They all have angle strain
 B. Both very small and very large rings are highly strained
 C. Six-membered and very large rings are not strained while the other ones are.
 D. Three and four-membered rings are strained, the other ring sizes are not.
 E. Cycloalkanes don't have any angle strain, they only have torsional strain.

29. What best characterizes a heterogeneous reaction?

- A. The reaction requires a catalyst
 B. The reaction generates one solid product and one liquid product
 C. The reaction involves a phase boundary
 D. The reaction is exothermic
 E. The reaction requires one solid reactant and one gaseous reactant

30. What is the major product of the periodate oxidation below?



- A. compound 1 B. compound 2 C. compound 3 D. compound 4
 E. Both 3 and 4 are valid representations of the major product.

-END-

Key:

1. C
2. E
3. E
4. D
5. B
6. E
7. E
8. D
9. E
10. D
11. B
12. D
13. C
14. B
15. D
16. C
17. B
18. B
19. C
20. C
21. B
22. B
23. E
24. E
25. D
26. C
27. A
28. C
29. C
30. C

Comments

qu. 6: exothermic refers to ΔH , there is no way of knowing ΔH based on this diagram alone.

qu. 15: no *trans* ring fusion is possible for two cyclobutane rings

qu. 17: π orbitals are molecular orbitals and play a role in the stability of more vs. less substituted alkenes. Carbocations usually don't have any π orbitals.

qu. 25: the hydrogens causing the 1,3-diaxial repulsion aren't shown here, nor do they have to be. We know that they have are there.

qu. 26: this is actually a hydride shift! These molecules are constitutional isomers.